Energy Matters

A School Energy Education Guide

CEE

Centre for Environment Education, Ahmedabad

Developed as part of the School Energy Project, Ahmedabad Eco-clubs, a project supported by the United States Agency for International Development, and in collaboration with the Green Schools Project, Alliance to Save Energy, Washington D.C., USA

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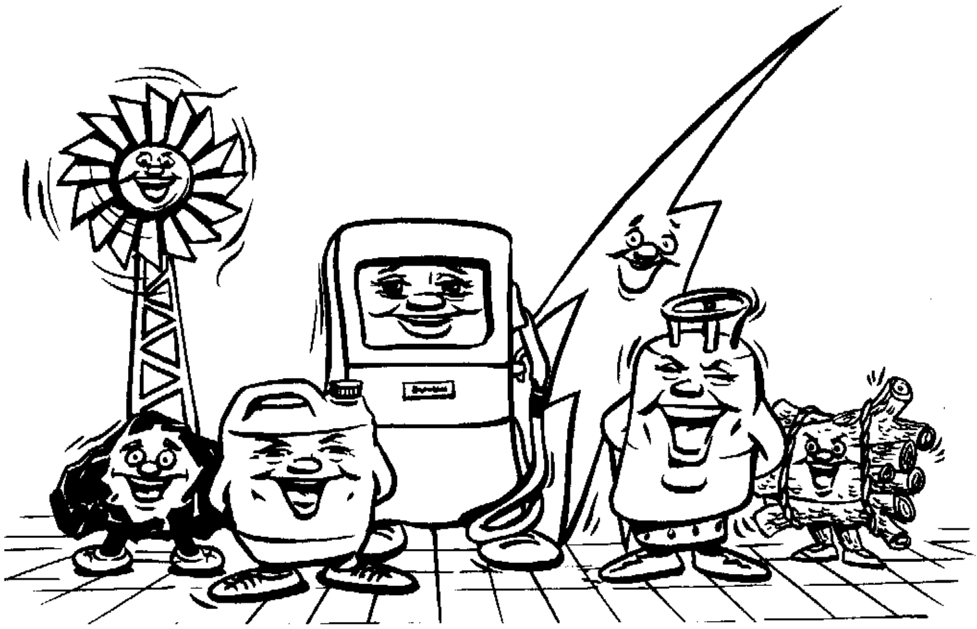

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Many of the activities in this manual have been inspired by a number of international and national energy education experiences and material. The activities in this manual have been adapted for use in the Indian context. We would like to acknowledge the sources from where we drew inspiration for these activities.

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2. "How Much My Habits Cost Me" based on "The Pay Me Game" in Let's Get Energized. California Energy Commission Education Office, USA. no date.
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4. "Check Your Energy IQ!" based on "Test Your IQ" in The Energy Source Book. TVA Environmental Research Center, USA. no date.
5. "The Big Bijili Ben" based on "All Steamed Up & Ready to Glow" in How Many Lightbulbs Does It Take To Change A People. A New England Electric System Company, USA. no date.
   Some of the activities in this manual also draw on other CEE's publications.

We would like to acknowledge the following publications that served as source for Background research.

1. Tata Energy Data Directory Yearbook 1999/2000. 1999. Tata Energy Research Institute, New Delhi.
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Centre for Environment Education (CEE) is a national institute of excellence for Environment Education supported by the Ministry of Environment and Forests, Government of India and affiliated to the Nehru Foundation for Development. The main objective of CEE is to create environmental awareness among children, youth, decision makers and the general community. CEE develops innovative programmes and materials and field-tests them for their validity and effectiveness. The aim is to provide models that could be easily be replicable to suit local conditions.

Foreword

Dear Teacher,

Energy conservation is a matter of vital importance to all of us. With rapid industrialization, urbanization and changing lifestyles, our energy consumption is increasing rapidly. While those of us who have access to energy, and can afford to pay for it, are enjoying the convenience and comforts it brings, in a country like India it is becoming more and more difficult for many people to find enough energy resources to fulfil even basic needs. Thanks to deforestation, for instance, women in many parts of the country have to walk hours to gather enough fuelwood to cook a day's meals.

Moreover, energy use brings its own consequences for the environment. While some of these are obvious — cutting of wood or emissions from power plants, other impacts are not so obvious. In our day-to-day life for instance, we may not feel the impact of depletion of non-renewable resources or the loss of biodiversity due to a dam.

Students need to become sensitized and start thinking about and analyzing various facets of these issues, so that when they grow up, they can take decisions with environmental sustainablility concerns factored in. There is a need to lay the foundation for a lifestyle which is environment friendly. Energy education at the school level is key to laying the foundation for environmentally aware and responsible citizens.

You, as teachers, face an enormous challenge in integrating energy education and environmental education into your classrooms. In order to realize the objectives of environmental education, you will have to guide the students to actively construct their knowledge of environmental concepts and issues through research, discussion, exploration, and application.

There are few materials specially designed to meet the needs of the Indian school situation. This guide attempts to plug this void by providing materials to enhance energy education, specifically from an Indian perspective and with a focus on the Indian school situation.

This, energy education manual focuses on energy and environmental concerns. Interdisciplinary by nature, energy concepts are appropriate for infusion in various subject areas. Activities in this guide are organized to help you discuss data and information through a series of activities, which portray energy challenges and dilemmas facing India and the world.

We hope "Energy Matters" can help you instruct and empower your students, as they participate in activities designed to conserve energy. Also, we hope the guide would enable students to understand the implications of their personal resource use and energy practices so that they can make informed decisions in future.

You, as teachers, play a pivotal role in this process by incorporating energy resource instruction into your classroom. We hope this guide supports you, the concerned parents and non-formal educators, in your endeavours.

CEE Team

Contents

AN INTRODUCTION TO ENERGY CONCERNS

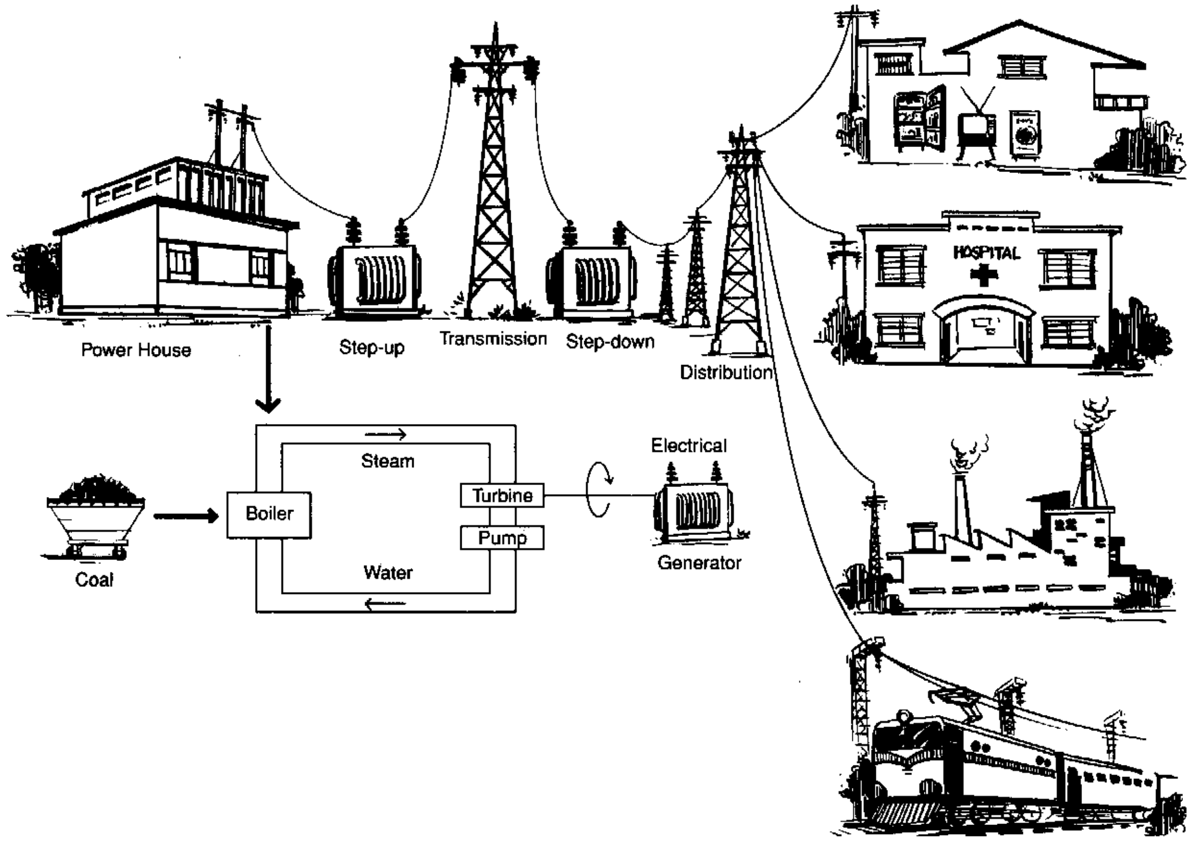
INTRODUCTION

Energy is all around us: in sunlight, in light bulbs and fans, in buses, cars and tractors, in TV sets, in the power of our muscles and in the food we eat. Energy is used to grow our food, to cook it, to keep us warm or cool, to move us from one place to another. It is a vital force in our lives. It is an essential ingredient of all activity on earth. Every technological advance in human history has, in a major way, been a result of our increasing ability to harness energy, convert it to useful forms and put it to various uses.

But the galloping increase in our use of energy has also created problems–some local, some global; some immediate, some looming ahead. For example, the increasing demand for fuelwood in rural and urban areas is contributing to degradation of forests in some parts of our country. The pollutants, that the burning of fossil fuels add to the atmosphere are making the air unsafe to breathe. According to a newspaper report, in Mexico City the air was unsafe to breathe for more than 300 days in 1990. Closer home, in New Delhi the air is so polluted that during the 1996 World Cup cricket series, the Australian cricket team refused to play in the city. As certain gases emitted by fuel combustion trap heat, experts predict that by the year 2100, average global temperature will have increased by anywhere between 1^{0} and 3.5^{0} Celsius.

So it is important that we take a close look at Energy–where it comes from, how we use it, what the environmental impacts are and what we can do about these.

Thermal Power- From Coal to Electricity



Energy Sources

Earth is a vast storehouse of energy. The fossil fuels beneath its surface, the wind and water on its surface, the plants growing on it, the sunlight falling upon it, are all sources of energy.

All energy sources can be classified into two basic categories: renewable and non-renewable, depending on the time period over which they can be replenished. The degree of renewability is determined by the human time-scale.

Non-renewable Sources
Fossil fuels are organic remains which have become coal, oil and natural gas through the process of fossilization over millions of years. They cannot be renewed over time-scales relevant for one human cycle. They are therefore non-renewable resources. So are nuclear fuels. Using the analogy of money in the bank, all these sources of energy are our 'capital' which may be extracted at as fast a rate as we want, but once they have been used up, they will be gone for ever.

The process of industrialization began more than two hundred years ago by harnessing greater energy through the use of machines. It was fuelled by the abundant and cheap supply of fossil fuels. The modern world continues to use enormous quantities of these fuels. The earth contains huge stocks, but in fixed quantities, of these sources of energy; these stocks are however being steadily depleted.

Renewable Sources
Renewable sources of energy are those which have the potential of being continually replenished. Using the earlier analogy, renewable resources are like a steady flow of interest on money in the bank. If the deposit of money is considered as a resource, as long as we withdraw either less than or equal to the interest which the deposit earns, the resource (deposit of money) can be considered to be renewing itself.

Most renewable energy resources are powered directly or indirectly by the energy of the sun, and therefore are likely to last as long as the sun lasts. These include solar radiation, energy from flowing or falling water and from wind. These resources can however be tapped only at a certain rate– if the extraction rate is higher than the production rate, then the renewable source is no more a renewable source. But they can last forever and are therefore also called perpetual resources. Other renewable sources of energy are biomass (food, wood, and animal and crop wastes), and animal and human muscle power. Biomass resources can, however, be exhausted if their rate of use exceeds the rate at which they are replenished.

Use of each of these sources of energy supply, both renewable and non-renewable, has its advantages and disadvantages, and its environmental as well as social and economic costs.

Another way of classifying energy sources is as non-commercial and commercial energy.

Non-commercial energy includes fuels such as firewood, dung and agricultural wastes which are traditionally gathered and not bought. These are also called traditional fuels. However, when these fuels become scarce, often they too have to be bought. Non-commercial or traditional sources of energy also include animal and human muscle power, but these are not included in most energy statistics. Nor are other sources of energy harnessed through traditional means, such as the power of flowing water used by water mills.

Non-commercial energy has been used by human beings for a long time. We use solar energy for drying grains, clothes, fish and fruits; and the energy of flowing water for grinding grain. We use animate power for transportation, ploughing, threshing, lifting water for irrigation, crushing sugarcane, etc. While these

sources of energy continue to be widely used in developing countries, these countries are now becoming increasingly dependent on commercial sources of energy.

Commercial energy, also known as industrial energy, is bought and sold. By far the most important forms of commercial energy are electricity and refined petroleum products. The primary energy sources such as coal, oil, natural gas, flowing or falling water, and nuclear fuels are converted into the secondary energy forms like electricity which are of greater use and value.

Commercial energy forms the basis of industrial, agricultural, transport and commercial development in the modern world. In industrialized countries, commercial energy is the predominant source not only for economic production but also for many household and personal tasks such as drying clothes, shaving, and even for brushing teeth.

The production and consumption of commercial energy from conventional sources–i.e., fossil fuels, large-scale hydroelectric and nuclear sources–is continuing to rise worldwide. However, efforts are also on to harness commercial energy from alternative renewable resources such as solar, geothermal, wind, wave, small-scale hydro and nontraditional biomass.

India: Current Energy Scene

India's energy requirement is increasing sharply because of rapid industrialization, mechanization, urbanization, commercialization, population growth, and changing lifestyles and aspirations of the people. As the supply of energy cannot keep pace with the rising demand, we experience energy shortages in our everyday lives–of petrol, electricity, cooking gas and fuelwood.

A significant feature of energy use in India is the substantial contribution of noncommercial sources of energy–nearly one-third of the energy used in India comes from non-commercial sources. India's rural population, which accounts for almost three-fourth of the country's total population, is largely dependent upon non-commercial sources for most of its energy needs. The large number of non-motorized vehicles (bicycles, cycle rickshaws, handcarts and animal carts) on the roads of all our towns and cities reflects the huge dependence on non-commercial sources in urban areas as well. It is also significant that in our country nearly half the total energy is consumed not by industry or agriculture, but by households–mainly for cooking food.

Non-commercial Energy

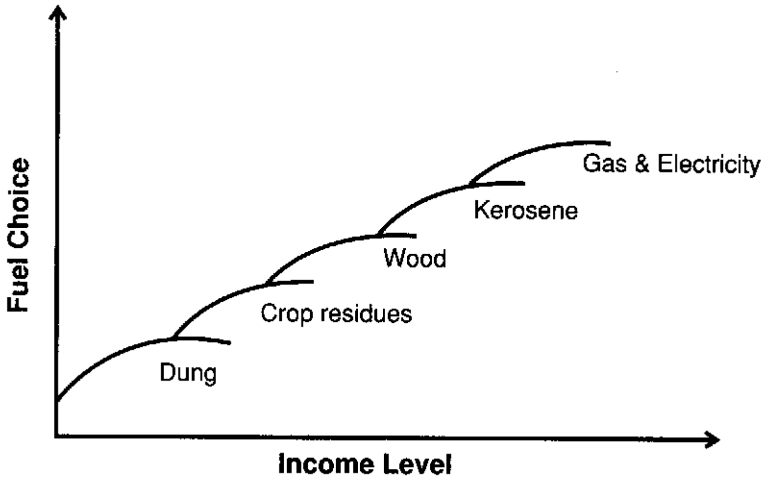
Accurate records of the use of non-commercial energy fuels do not exist. But it is estimated that traditional biomass fuels–firewood, agricultural residues and animal waste–meet between one-third and one-half of India's total energy needs. Non-commercial energy sources provide over three-quarters of all household needs, primarily in villages, but also in towns and cities.

Firewood continues to be the major fuel for cooking energy in the country, providing 51 per cent of the cooking energy in rural and 35 per cent in urban areas. In urban areas firewood is used primarily by the poor. While firewood is the preferred biomass fuel, the dependence on different biomass fuels (dung, crop residues) varies from region to region, owing to India's vast expanse and regional diversity. Local climate, vegetation type and firewood availability often determine the nature of biomass use in different parts of the country.

While biomass fuels have traditionally been non-commercial, the rapid denudation of forests and the consequent reduction in the availability of firewood has resulted in some non-commercial fuels becoming marketed products not only in urban but also in rural areas.

The scarcity of fuelwood has two major consequences:

1. It leads to an increase in the price of fuelwood.
2. It results in a shift to low quality fuels among the poor.



When faced with firewood scarcity, the rural poor often shift to other sources of fuel such as cattle dung, crop residues, woody parts of shrubs, roots, weeds, and plants such as the prickly lantana. All these have less calorific value than wood and give off a lot of smoke. In urban areas, where firewood is used mainly by the poor, those who cannot afford to buy alternative fuels sometimes turn to nonfuels such as discarded tyres and waste paper, especially for warmth on cold winter nights.

A strong relationship exists between income and the type of fuel used. This relationship manifests itself in an 'energy ladder': With an increase in income (or in the level of development of an area) people switch to higher quality fuels, i.e. they shift to fuels that are more energy efficient as well as cleaner and more convenient to use. The normal progression for lighting is from vegetable oil to kerosene to electricity. For cooking, the sequence is from fuelwood to charcoal to kerosene to LPG to electricity.

Commercial Energy

Although statistics on commercial energy are easily available, the absence of accurate statistics for non-commercial energy makes it difficult to say precisely how much the former contributes to India's total energy use. The share of commercial energy in India is, however, expected to grow from an estimated 66 per cent in 1990 to 80 per cent in 2000.[1]

There has been a rapid rise in energy demand in the past two decades. This was caused by growth in the industrial and transportation sectors, population growth, growth of urban population, rise in residential energy use that has accompanied higher incomes, and greater access to consumer products especially among the middle and upper income groups. There has also been a substantial increase in the use of power in the agricultural sector. For example, the number of electrified pumpsets used for irrigation increased almost ninefold, from 1.4 million in 1971 to 11 million in 1996. In India the largest user of commercial energy is industry, followed by agriculture.

Environmental Costs of Energy Use

The use of each of the following conventional energy resources has some adverse environmental consequences at some stage–from its extraction, through processing and transportation to its end use.

Biomass

Biomass is a renewable resource, but when consumed faster than it can regenerate, biomass denudation (especially deforestation) results in soil erosion, loss of productivity of soil, disruption of stream flows and loss of habitats.

Biomass is considered to be a carbon-neutral energy source because green plants absorb carbon dioxide for photosynthesis and give off oxygen, thus establishing an overall carbon dioxide balance. But the burning of biomass fuels also emit other carbon-containing materials, namely, carbon monoxide, other hydrocarbons, and suspended particulate matter like soot and ash. It therefore causes air pollution and emission of carbon dioxide and methane contributes to the build-up of greenhouse gases that cause atmospheric warming.

Scarcity of fuelwood in some parts of the country has increased the pressure on other biomass resources such as cattle dung and crop residues. Use of these resources as fuel takes them away from other more appropriate uses as fertilizers and mulch. The rising demand for fuelwood by the urban poor who cannot afford the more expensive commercial fuels has resulted in a sharp increase in fuelwood prices in urban areas. This has led to trucks and wagon-loads of firewood harvested from forests at ever increasing distances and hence increasing costs, coming to major cities. Of immediate concern is also the fact that the carbon monoxide and smoke from open woodstoves in poorly ventilated dwellings affects the health of the rural and urban poor, especially women who are the main users of biomass fuels.

Coal

Coal is mined in two ways–underground mining and open cast mining. Both have their specific environmental effects but together they degrade forests and land, pollute water and air, and affect the health of miners and people living near the mines. Open cast mines are more efficient because they permit almost complete recovery of coal. In underground mines, 40 to 60 per cent of the coal has to be left in place to hold up the structure. Yet occasional roof collapse and explosions in the underground mines kill miners. The enclosed, coal-dust laden atmosphere affects their health. Under present practices, open cast mines are safer but destroy, often permanently, the vegetal cover and soil, and disrupt and pollute the aquifers and streams. Coal dust generated by mining pollutes the air for miles. After coal is mined, it is sometimes washed to remove impurities like clay. This uses and pollutes a lot of water.

The worst environmental problem associated with coal is the air pollution generated when it is burned. Coal is about the "dirtiest" fuel and produces twice as much carbon dioxide (the main greenhouse gas which leads to global warming) per unit of energy as natural gas and 25 per cent more than oil. In India coal combustion accounts for 66 per cent of carbon emissions. Coal use in the country is projected to treble by the year 2010 to over 600 million tonnes.[1]

Coal is also the primary source of oxides of sulphur and nitrogen that combine with water vapour in the atmosphere to cause acid rain. The acidic nature of the pollutants causes damage to buildings, monuments, metals, vegetation, animals, aquatic ecosystems and human health. Although the sulphur content of Indian coals is low (1 per cent), the large amount of coal combustion in thermal power plants offsets this advantage.

Indian coals contain high amounts of ash (25 to 40 per cent). The burning of the 150 million tonnes of coal by thermal power stations in the country every year generates about 50 million tonnes of fly ash. The disposal of fly ash is one of the biggest solid waste disposal problems in India. For every megawatt of installed capacity, approximately 0.04 hectare of land is required to pile up the ash eight to ten meters high.[2]

A majority of thermal power plants in India are 200 to 210 MW units. So you can work out how much land each coal-based power plant requires just to dump the fly ash! Efforts are on to develop uses for fly ash. It has been commercially used for making bricks, blocks and as an ingredient in cement. It has also been used to fill up old mines. But at present only about 3 per cent of the fly ash generated each year is being put to these uses.

Oil and Natural Gas

The process of oil and natural gas exploration is very energy intensive and so is extraction. Both exploratory and commercial drilling, even if done with a lot of care, result in the release of some toxic chemicals and in pollution of water and air. Accidental explosions and occasional leaks occur both during exploration and production. A major blow-out occurred in Pasarlapudi in Andhra Pradesh in January 1995 when a well was being drilled. The fire raged for 66 days before it was finally put out. Besides the damage it caused to the drilling equipment and the smoke and other pollutants it added to the air, the fire drove thousands of people from their homes and scorched their crops and trees.

Today all oceans are contaminated to some degree by oil slicks (thick patches of oil floating on water) and petroleum residues. These come from offshore oil wells, ships (from collisions, leaks and flushing of tanks), and also as run-off from land-based oil facilities and waste oil. When oil spills in a natural ecosystem on land or in water, it kills creatures by cutting off their air supply, enters the food chain and disperses in the sediments and soils. In the sea, oil is especially harmful to life forms that cannot swim away, such as coral. The infamous accident of the oil tanker Exxon Valdez in May 1989 spilled nearly 42 million litres off Alaska's coast, along 1,930 km of coastline killing at least 1,00,000 sea birds, 1,000 sea otters and innumerable seals. In June 1989 an oil spill threatened the Indian coast when a Maltese tanker, MT Puppy, collided with a British ship, spilling over 5,000 tonnes of oil into the open seas off Mumbai.

Natural gas is a 'cleaner' fuel than either oil or coal. It is composed mainly of methane which is a greenhouse gas that traps ultraviolet radiation more effectively than CO_2. Therefore unusable gas at oil wells is flared rather than being allowed to escape into the atmosphere.

The commercial processing of petroleum products produces solid wastes such as salts and greases. After all the refining and processing, the oil is ready as a fuel. It is then used in vehicles and furnaces. When burned, it produces air pollutants such as sulphur dioxide, nitrogen oxide, carbon monoxide, and, carbon dioxide. Another major group of pollutants are the lead compounds from the lead added to petrol to improve its octane rating to prevent 'engine knock'.

The phenomenal increase in motor vehicles in India–from 1 crore in 1986 to 3.3 crores in 1996–has resulted in a corresponding increase in the use of petroleum in transportation. As this increase in vehicles has occurred mainly in urban areas, the air quality in most Indian cities and towns has deteriorated significantly. In addition, unrestrained industrialization and burning of wastes make matters worse.

Smog is now a common feature in many cities. The smog and other air pollutants lead to respiratory and eye problems among urban dwellers. According to a recent World Bank report, every year 40,000 people die prematurely in India because of air pollution. In Delhi the number of people, especially children, suffering from respiratory diseases has registered a significant increase in recent years. Currently, more than 11 per cent of school children in the city suffer from asthma.

The lead compounds emitted by vehicles using leaded petrol affect normal functioning of the nervous system by slowing reaction time and attention span. Lead compounds act much faster on children and can cause brain damage. Several countries have banned the use of leaded petrol. In India a public interest petition about the effects of lead on human health led to the introduction, in April 1995, of lead-free (unleaded) petrol in the four metropolitan cities, and a few years later to other cities as well. Switching over completely to unleaded petrol will require considerable expenditure on fitting all vehicles with catalytic convertors and modern fuel-injection systems, and an investment of several crores in the refining process. Besides, there already is a controversy about whether unleaded petrol is in fact better because it replaces lead-fumes with cancer-causing benzene and butadiene emissions.

Some scientists believe that sulphur dioxide emissions by the Mathura refinery pose a grave threat to the Taj Mahal. This gas under humid conditions is converted into sulphuric acid which can corrode the marble. Others believe that there is an equally serious threat from pollution caused by the thousands of vehicles that ply in Agra and from the diesel generators now widely used to combat power shortages in the area. Other major sources of sulphur dioxide in Agra are the hundreds of small coal-burning industrial units, foundries and brick kilns. Corrosion noticed in historical buildings such as the Victoria Memorial in Calcutta, the Red Fort in Delhi and the Charminar in Hyderabad is also attributed to the vehicular emissions and other air pollutants.

Hydroelectricity

About 28 per cent of electricity produced in India is generated by turbines turned by the force of falling and flowing water. Hydropower generation requires the building of dams behind which water is impounded. Although generation of hydroelectricity does not release any carbon dioxide, the rotting of vegetation caused by the submergence of forests produces methane which is a greenhouse gas.

Large dams are a controversial environmental issue in India. The Narmada Valley Development Project, for example, involves the building of 30 major dams and hundreds of smaller ones to provide water for irrigation and drinking to millions of people. It is also expected to provide 1.4 million kilowatts (1.4 GW) of electricity. At the same time it is likely to displace over a million people. Anti-dam activists consider the rehabilitation plans of the government to be insensitive and woefully inadequate.

Large dams cause vast tracts of valuable forests, wildlife habitats (both terrestrial and aquatic) and biodiversity, as well as agricultural land to be lost due to submergence. The water-table rises and often leads to salinization and waterlogging due to poor management. When that happens on agricultural land, it affects the productivity of the soil. Waterlogging also leads to a rise in various diseases, notably malaria.

Defective design and poor quality of construction have been known to lead to dam breaches resulting in loss of human life. The breaching of the Machchhu dam in Gujarat in 1979 is a prime example. Its gushing waters killed several hundred people and destroyed many villages as well as the town of Morvi. Some of these problems can, theoretically, be prevented through environmental impact assessment of the project, careful construction, proper maintenance and management. However, practical implementation of safeguards is often difficult.

Another major concern is the threat of earthquakes caused by impounding such large volumes (and weight) of water. There is evidence of such occurrences all over the world. The Koyna Dam in India is an example. It was built in 1962 in a stable area known neither for geologic faults nor seismic activity. In 1967 the area was rocked by an earthquake that killed 177 people, injured 2,300 and rendered thousands homeless. The threat of earthquake in an area known for its earthquake proneness is the most contentious issue in the case of the Tehri Dam.

Nuclear Power

In some respects, nuclear power is the 'cleanest' of all energy sources. Its generation and use do not emit any carbon dioxide or other greenhouse gases. Nor does it cause acid rain or urban smog. Yet it is the most controversial source of energy. The basic cause of concern is the possibility of an accident. Although the probability of accidents is low, should one happen, the consequences are serious. Another unsolved problem is the management and disposal of radioactive wastes.

The accident at the Three Mile Island nuclear power plant in USA in March 1979 and the explosion at the Chernobyl power plant in Ukraine (which was then a part of the former USSR) in April 1986, that released large amounts of radioactivity into the atmosphere, have intensified the fear that human errors in

operation and maintenance could lead to major catastrophes. Critics believe that Indian nuclear plants are poorly maintained and that accidents, mostly unreported, occur almost every year.

Nuclear power plants use radioactive materials and produce radioactive waste. The power plants have a life of 30 to 40 years, after which they have to be decommissioned. But they contain a lot of radioactive material. It takes from thousands to millions of years for most of these materials to lose their radioactivity. During this time human beings and other life forms exposed knowingly or unknowingly to nuclear radiation are at risk. Exposure to radioactivity is known to cause cancer, genetic defects, and even death.

Several methods of dismantling ageing nuclear plants and managing the safe disposal of radioactive waste have been suggested. All of them essentially deal with safe storage of radioactive materials over a geological timespan. However, it remains an intractable problem as we do not as yet know how to handle and dispose of these materials one hundred per cent safely. The proponents of nuclear energy maintain that science and technology have tackled many intractable problems in the past and will find a solution for this one too.

Options for the Future

Although India uses much less commercial energy than industrialized countries, the rapid industrial and commercial expansion, the projected growth of population, and increasing consumerism leading to greater per capita energy use, point to substantial increase in energy use in future. Estimates predict a fourfold increase in commercial energy consumption in India by 2025. In the same period, carbon dioxide emissions could increase sixfold as the use of traditional biomass fuels gives way to greater use of fossil fuels.

To improve our energy future, we need to take steps to increase energy supplies sustainably and reduce energy demand through efficient use. We need to shift towards renewable energy resources that are more equitably distributed, more affordable and less environmentally destructive than fossil fuels. At the same time we must recognize that however rapidly we move towards renewable energy sources, we will remain dependent on fossil fuels for several decades to come. We therefore need to reduce the environmental impacts of our current energy sources by finding ways of burning them more cleanly and efficiently.

Energy Conservation

Energy conservation means using energy more efficiently and less wastefully. Conservation of energy is an important energy resource because a unit of energy saved is as good as a unit of energy generated. Besides, it is cheaper to save energy than to produce it, and the saved energy becomes available for some other use. In essence, it means "doing more with less".

At the individual level, energy can be saved basically in two ways:

1. By changing our energy-wasting habits and lifestyles
Obvious examples from our daily lives of changing wasteful habits include switching off a light when it is not needed, walking or riding a bicycle instead of using a two-wheeler or a car for a short trip, regularly defrosting the refrigerator, or even turning the tap off while brushing one's teeth (not only does that save water, but also the energy used for pumping the water). Such changes in habits do not cost any money.

Less obvious but equally important is cutting down wasteful consumption. All commodities require the input of energy at all stages of production, packaging and transportation. Take a shirt, for example. The

production of the fibre (whether natural or synthetic), the yarn, the fabric and the shirt all require input of energy. So do the plastic bag and the carton in which it is packed. Energy is used to transport all the raw materials as well as the finished products. The shirt therefore has a certain amount of energy embodied in it. So by not buying the shirt that one does not really need, one will be saving more than just the energy spent on a trip to the store.

2. By using energy-efficient equipment
By doing so, we can use less energy to do the same amount of work, and in some cases even more work. At the individual level, examples include using a pressure cooker, an energy-efficient model of a refrigerator or a chulha, or a compact fluorescent light bulb. According to one estimate, if just 20 per cent of the more than 30 crore conventional light bulbs in use in India in 1990, were replaced with compact fluorescent light bulbs by the end of the century, the country's power requirement would be substantially reduced. India could avoid building 8,000 MW of new power capacity. India could also halve its firewood requirements just by doubling the fuel efficiency of woodstoves.

The second option requires investment in either new equipment or in proper maintenance of older equipment (for example, installing an improved woodstove, keeping the car engine tuned), but it ultimately leads to savings in energy as well as in money. Energy-efficient models may cost more initially than the conventional models but they save money in the long run by having a lower life-cycle cost, i.e., initial cost plus lifetime operating costs. And the saving in energy is not a one-time saving because an energy-efficient device goes on saving energy throughout its life. Energy conservation is often the cheapest, and perhaps the largest source of energy available to us. Adoption of a combination of the two approaches, by individuals in their personal lives and by society as a whole, in every sector of the economy, is required for meeting our energy requirements affordably and with tolerably low environmental impact.

1. Source: TERI, TERI Energy Data Directory and Yearbook 1994/'95. New Delhi, Tata Energy Research Institute. 1994.

2. Source: Biswas, D., and S.A.Dutta. "Vehicular Pollution; Combating the smog and noise in cities. "The Hindu Survey of the Environment 1994: 41-45. 1994.

1 LINKS IN A CHAIN

BACKGROUND

Energy can neither be created nor destroyed, but it can be transformed from one form to another. This is the First Law of Thermodynamics. We can see the inter-conversions in various forms of energy in our day-to-day life. In order to understand the various energy transformations, we need to first understand the different forms of energy.

Potential energy is stored energy that can be used. A ball held up in your hand that could be dropped, or water behind a dam that could be released, possess potential energy. This energy will not do any work until released or changed.

Kinetic energy is the energy of motion. When you drop the ball or release the water from the dam, the potential energy is converted into kinetic energy.

Mechanical energy is the energy of a moving object. It is the moving force behind all machinery.

Electrical energy is the energy contained in the separation of oppositely charged particles.

Solar energy is the energy transmitted from the sun. It is free, clean, and nonpolluting, and does not involve the use of dwindling, finite sources of energy. The solar radiation striking earth's surface each year is more than 10,000 times the world's energy use. Photovoltaic cells generate electricity on absorption of solar radiation.

Thermal energy is the energy asociated with heat. It is used to convert water into steam that can turn a turbine to generate electricity. This is an example of thermal energy converted into mechanical energy that is transformed into electrical energy. This electrical energy can be converted to radiant energy in a light bulb, or thermal energy in a heating coil.

Nuclear energy is the energy from the forces that hold the tiniest specks of matter together in the nucleus of an atom.

Chemical energy is the energy tied up in chemical molecules of matter. It is the energy contained in the chemical bonds of foods and fuels, and is released when those bonds are broken by chemical reaction.

Measuring Energy

Joule (or J) is the basic metric unit for measuring energy. It equals 0.239 calories.
1 calorie = energy required to raise the temperature of 1 gram of water by 1°C.
Large amounts of energy are measured in the units below:
megajoule = 10^6 joules   gigajoule = 10^9 joules   tetrajoule = 10^{12} joules   petajoule = 10^{15} joules

Power is the rate at which energy is used, or energy per unit of time. The international unit of power is Watt (W).
1 Watt = 1 joule per second
1 watt-hour is the amount of energy used to produce a power flow of one watt for one hour.
1 kilowatt-hour(kWh) = 1000 watt-hours = 3,600 kilo joules (kj) which is the energy used by one 100 W bulb burning for 10 hours and equals 1 unit of power.
1 kilowatt(kW) = 1000 Watts = power consumed by ten 100W bulbs.
1 megawatt (MW) = 10^6 watts   1 gigawatt (GW) = 10^9 watts   1 terawatt (TW) = 10^{12} watts.
A widely used unit for measuring commercial energy is mtoe (million tonnes of oil equivalent).
1 mtoe = 12, 000 GWh = 10.2×10^{12} kilocalories.

Energy Efficiency is the percentage of the total energy input that does useful work and is not converted into low-quality, usually useless heat in an energy conversion system or process.

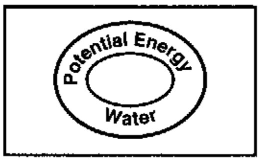
LINKS IN A CHAIN

Objectives

To help students
- Understand and describe eight forms of energy–light, heat, sound, electrical, mechanical, magnetic, chemical and nuclear.
- Observe and describe energy transformations.

Procedure

1. Before the class, arrange for a bulletin board and the following chart paper cutouts.
   A. A circle labelled "Sun"
   B. A square labelled "TV"
   C. Eight links (cut according to the pattern shown on the "Link Pattern" on page 12) labeled as follows.
      a. Potential energy, water
      b. Heat energy, water vapour
      c. Kinetic energy, rain
      d. Potential energy, dam/ reservoir
      e. Mechanical energy, turbine
      f. Electrical energy, generator
      g. Electrical energy, television
      h. Light energy, picture



2. Place the circular sun-piece at one end of the board and the square TV piece at the other.
3. Demonstrate to the class the energy transfers by pinning the eight links on the bulletin board as you read out the chain of energy transformations in the following narrative:

   Energy from the sun runs your television set. The energy is changed and transferred many times between the sun and the television screen. The sun's energy is stored on the earth in water, plants and fuel. The sun's energy heats water (for example, in oceans, lakes and other bodies), evaporating it. The water rises into the atmosphere as water vapour. High in the atmosphere, the vapour cools, condensing and forming clouds from which fall rain or snow. The rain falls on the earth and some of it flows into rivers or lakes. When rivers are dammed, the water is stored temporarily behind the dams. When the water is released from a hydroelectric dam, the force of the water can turn a turbine.

   As the turbine spins, it spins the generator to which it is connected. The spinning of the generator produces an electrical current, which is then sent along wires to our house. The current travels through the chord of your television set, which uses it to produce the light that you see as the picture.

Subject
Science

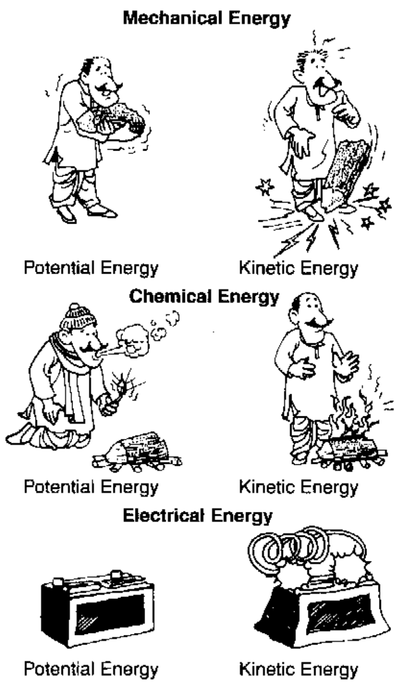
Group Size
Groups of 5 to 10

Level
Standards 6-8

Materials
Writing materials, chart papers, scissors, transparent tape, bulletin board, sketch pens

Place
Inside the classroom

Duration
30 minutes

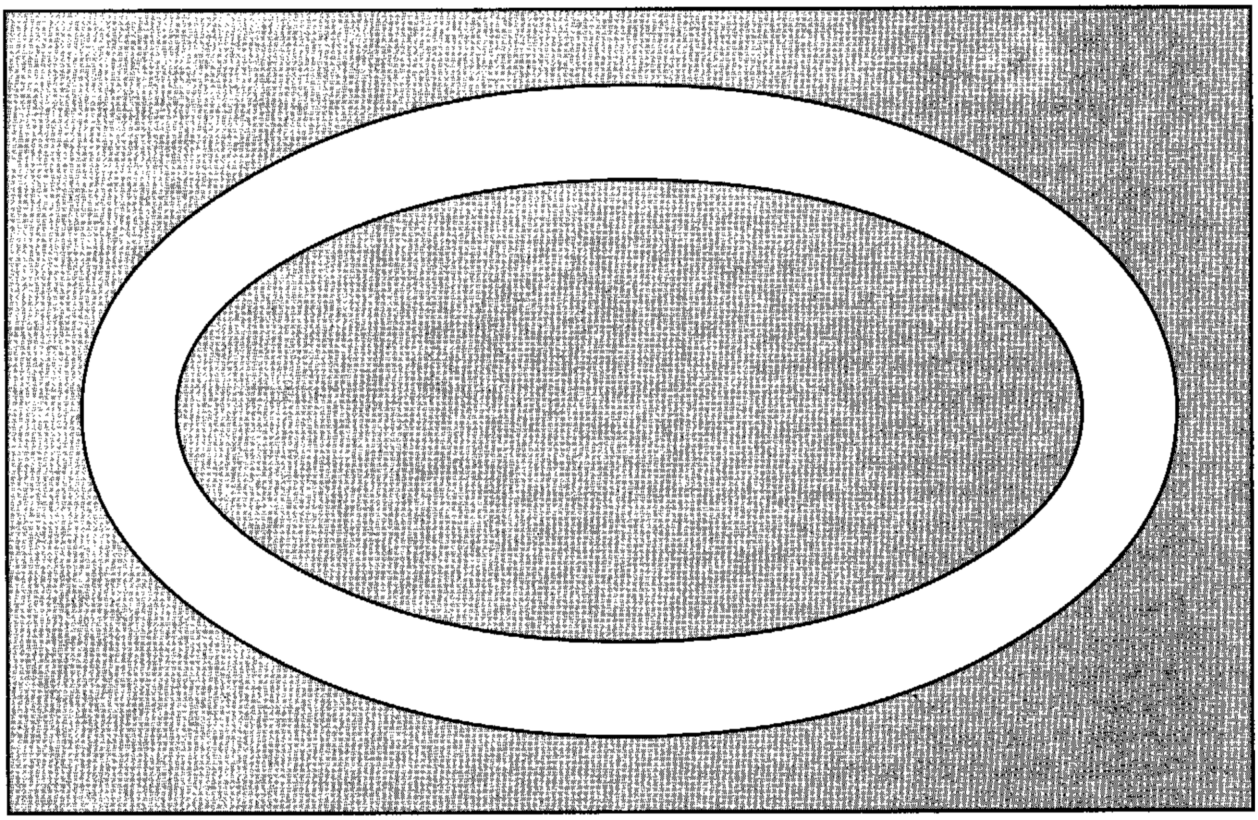


LINKS IN A CHAIN

Extension/ Variation

- Ask the students to construct another energy transformation chain by choosing a topic they encounter every day. For example: Energy chains from the sun to a roti or rice that we eat, or from the sun to an electric water heater in our home.Tell them to also develop a script for the narrative.

Link Pattern



USEFUL AND WASTEFUL ENERGY

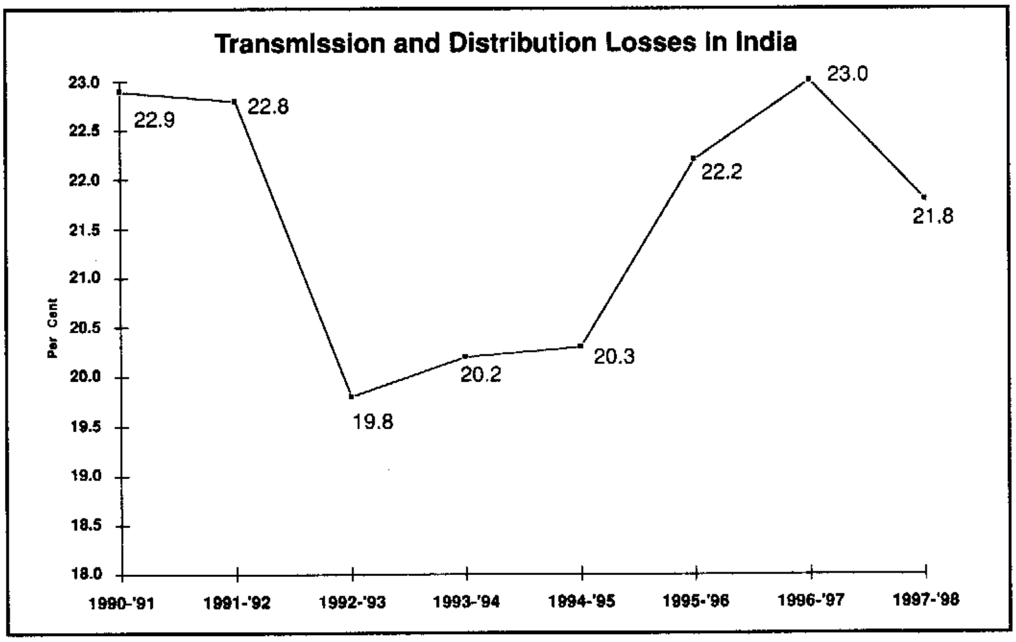
2

BACKGROUND

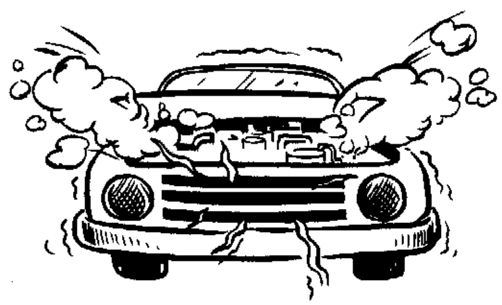
We all have noticed a vehicle's engine getting heated when the vehicle is driven for a long time. Similarly, heat is emitted from a bulb primarily meant to give light. In other words, when energy is harnessed to do useful work, a part of it is also dissipated into the environment in the form of waste heat, sound, etc.

While power generation in India has increased considerably from 79,230 GWh in 1975-'76 to 2,87,028 GWh in 1991-'92, there are some areas of concern with respect to generation and transmission. Transmission and distribution losses in India have increased from 17.5 per cent in 1970-'71 to 22 per cent in 1992-'93. Improper load, too many transformation stages, unplanned expansion of distribution systems, etc., all contribute to the high transmission and distribution losses. In addition, non-technical losses because of pilferage and theft are also significant.

Another area of concern is the generation performance of power plants (the common indicator for measuring this is Plant Load factor (PLF)). The PLF of State Electricity Boards, in 1996 was as low as 44 per cent.



Source : TEDDY 1999-2000



USEFUL AND WASTEFUL ENERGY

Subject
Science, Social Studies
Group Size
Groups of 2 to 5
Level
Standards 6-8
Materials
Writing materials
Place
Inside the classroom, at home
Duration
One week

Objectives

To help students to
- Learn about different forms of energy.
- Understand that whenever energy changes from one form to another, there is loss of useful energy–mainly in the form of waste heat, sound, etc.

Procedure

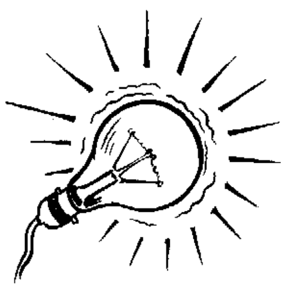
1. Ask children to observe devices like electric bulb, stove, kerosene lamp, irrigation pump, vehicles, flour mill, fan, television, etc., in their homes.
2. Ask them to record the main purpose of using the device.
3. Apart from the useful form of energy, which other form/ forms of energy are released from the device? For example, heat from an electric bulb, sound from an engine, etc.
4. Ask them to record the wasted energy form in the following table.

Useful and Wasted Energy

S. No	Device	Energy used for	Useful energy form	Wasted energy form
1	Electric bulb	Lighting	Light	Heat
2	Stove			
3	Kerosene lamp			
4	Irrigation pump			
5	Vehicles			
6	Flour mill			
7	Fan			

Extension/ Variation

- Discuss with the children whether the wasted energy could be put to work in each case.
- Are there any alternative devices that are more energy efficient, to replace the devices listed on the table, like compact fluorescent light bulbs instead of filament bulbs ?



ENERGY TRENDS 3

BACKGROUND

We have not always used as much energy as we use today. Primitive people who lived around one million years ago used only the energy contained in their food. Energy plays a key role in development, but the generation and use of energy also bring along negative environmental impacts.

In India there has been a growth in the primary energy consumption at the rate of about 7.7 per cent a year over 1987 to 1997. Specifically, while the world's consumption of energy grew only by 1 per cent during 1997 over the previous year, it grew by 6.1 per cent in India.

Even today traditional sources like fuelwood, agricultural wastes and animal residue, contribute 40 per cent of the total energy consumption in our country. Oil is the main energy source for the transportation sector in India. Coal and natural gas are used for industrial heating and processes. Oil, coal, biogas, natural gas and firewood are used for domestic uses in many areas. Electricity is used in all sectors, for a variety of activities including, lighting, heating, household tasks, telecommunications and manufacturing, to name a few. Apart from commercial energy, a large amount of traditional energy sources are used in the country, mainly to meet the rural energy demand.

Modern industrial society is based on a supply of cheap energy. While meeting demands, the energy industry needs to respond to both economic and environmental imperatives imposed by society.

Distribution of Households in India by Type of Cooking Fuel : 1991

Fuel	Per Cent of Households
Kerosene	7.16
Electricity	0.31
Coal/ Coke	3.47
Charcoal	0.77
Cooking Gas	7.94
Wood	61.50
Biogas	0.49
Cowdung Cake	15.39
Others	2.91

Source : The Citizens' Fifth Report, Part II : Statistical Database

ENERGY TRENDS

Objectives

To help students learn about energy sources at various points in history and to understand the changing trends with regard to these.

Subject
Science, Social Studies
Group Size
Groups of 5 to 7
Level
Standards 5-7
Materials
Notice board,
felt pens
Place
Inside the classroom
Duration
30 minutes

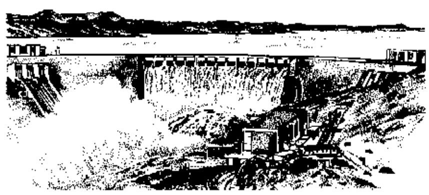
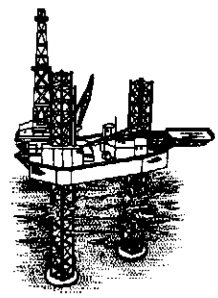
Procedure

1. Divide the class into groups of 5 to 7 and assign one of the following periods to each:
   a. Early Eighteenth Century (1700s)
   b. Nineteenth Century (1800s)
   c. Early Twentieth Century (1900s)
   d. Present Day (2000s)
   e. Future (2050s)
2. Ask each group to meet and do the following exercise:
   Imagine that you lived during the period assigned to your group. What kind of energy would you have used for the activities given in the table below?
3. Ask each group to list the types of energy used for the activities today and compare it with the energy used in the period assigned to them, from most-used energy source to least-used energy source.
4. Ask each group to present their list and say why they ordered the energy sources as they did.

Energy Used

Activity	Energy Used	Energy Used Today
Travel		
Cool your home		
Light your home		
Make tools		
Grow food		
Cook food		
Store food		
Wash clothes		
Entertain yourself		



ENERGY TRENDS

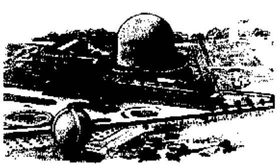
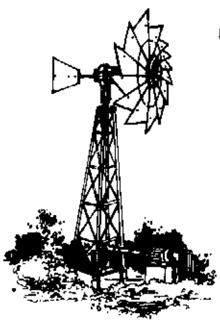
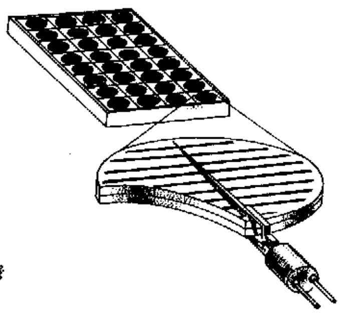
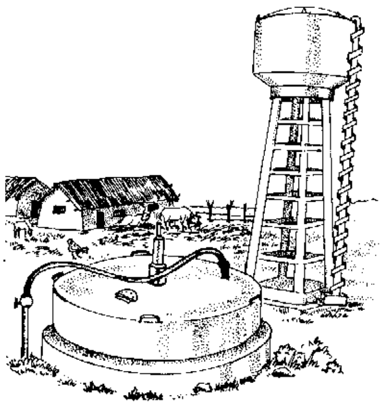
5. Draw the following chart and ask the students to copy it in their notebooks. Ask them to fill the boxes for each period when that energy occurs. When finished, the students will have a table of energy sources through recent history.

Energy Sources Through Recent History

Type of Energy	1700s	1800s	1990s	2000s	2050s
Animal power					
Wind power					
Water power					
Human power					
Electricity					
Oil and Natural gas					

Extension/ Variation

- Summarize the data represented by the chart for the class. Emphasize the continual change in sources of energy through time.
- When the chart is completed, discuss it. Which energy sources occur throughout all periods? Why? Which energy sources may not be available in the future? What will replace them?

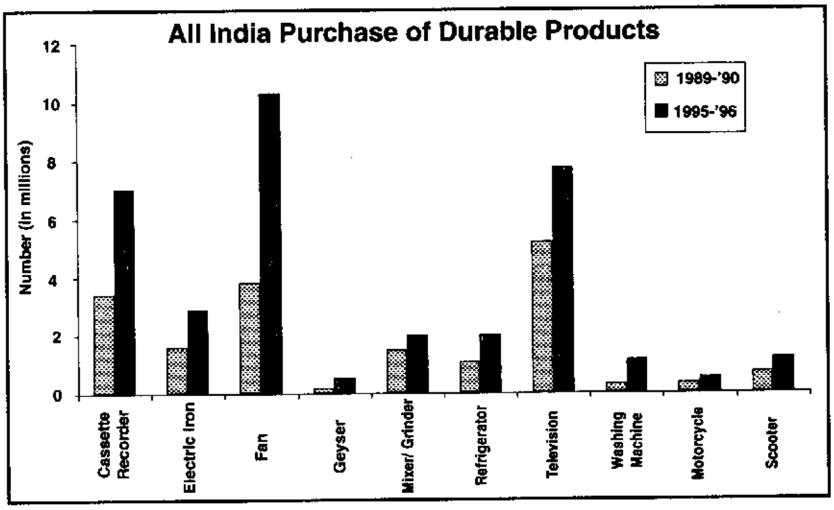





DO I REALLY NEED IT? 4

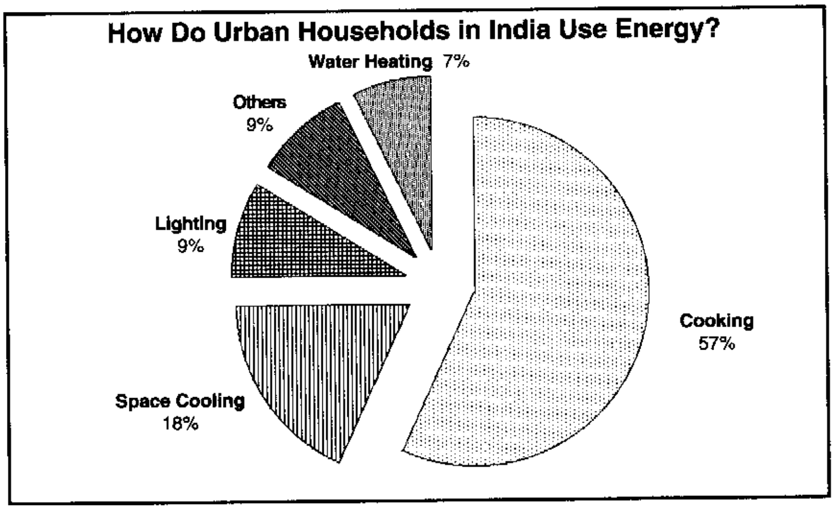
BACKGROUND

The rapid pace of urbanization and diverse urban growth patterns involve many basic structural changes in the economy and in lifestyles, that have important implications for energy use. The growth of income in urban areas is leading to increased demand for energy, particularly of electricity, for end uses such as refrigeration, air-conditioning, etc. The domestic sector accounts for 40 to 50 per cent of the total energy consumption in the country. Electricity consumption in the domestic sector has increased at a compounded growth rate of about 10 per cent per annum during the last four years, and nearly doubled its share in total electricity consumption. Increased urbanization and increased use of domestic electrical appliances are possible reasons for such a trend.

When considered as a nationwide total, residential energy consumption becomes a large factor, and conservation of home energy can lead to substantial reductions in energy use.



Source : TEDDY 1999-2000



Source : TEDDY 1997-1998

DO I REALLY NEED IT?

Objectives

To help students categorize domestic electrical appliances into "needs", "wants" and "luxuries".

Subject
Language, Science

Group Size
Entire class

Level
Standards 6-8

Materials
Writing materials

Place
Inside the classroom

Duration
30 minutes to 1 hour

Procedure

1. Ask the students to imagine that the human population on earth has increased drastically and the government has made arrangements to transfer some citizens to Mars, where living conditions have now artificially been created. Air, water, raw food and shelter would be provided to everyone by the government in Mars. Moreover, the families will be translocated collectively, hence they need not worry about missing their relatives–parents, sisters, brothers, friends, pets, and others.
2. Inform the students that Mars has as yet very limited power generating capacity and so ask them to list only 20 household appliances like fridge, television, radio, fan, light bulbs, etc. that they would like to take with them.
3. After they have made their lists, inform them that the spaceship has become overloaded and hence the commander has asked that 15 of the appliances be discarded by each of them. Ask them to list the 15 things they wish to discard.
4. After the students have discarded 15 items from their list, inform them that in the meantime the population on the earth has doubled. The commander has been commanded to take more people. This would mean that each passenger can carry a maximum of only 2 appliances with them. The spaceship commander has ordered them to select their 2 appliances quickly so the ship can move!
5. Analyze the objects they selected at each instance. Collectively through discussions, decide which appliances are essential for daily life and which are not. Ask them to classify the appliances as "needs", "wants" and "luxuries".

Extension/ Variation

- Ask the students to brainstorm on electrical appliances whose names begin with each alphabet, from A to Z.
- Ask each student to cut out pictures of various electrical appliances from old magazines and paste them on separate charts titled "Needs", "Wants" and "Luxuries", according to their individual decisions.

5 ENERGY RELAY

BACKGROUND

The sequence of "who eats whom" in an ecosystem, is called a food chain. It determines how energy moves from one organism to another through the ecosystem. Each organism in an ecosystem is assigned a trophic level or a feeding level, depending on whether it is a producer or a consumer, or a decomposer based on what it eats.

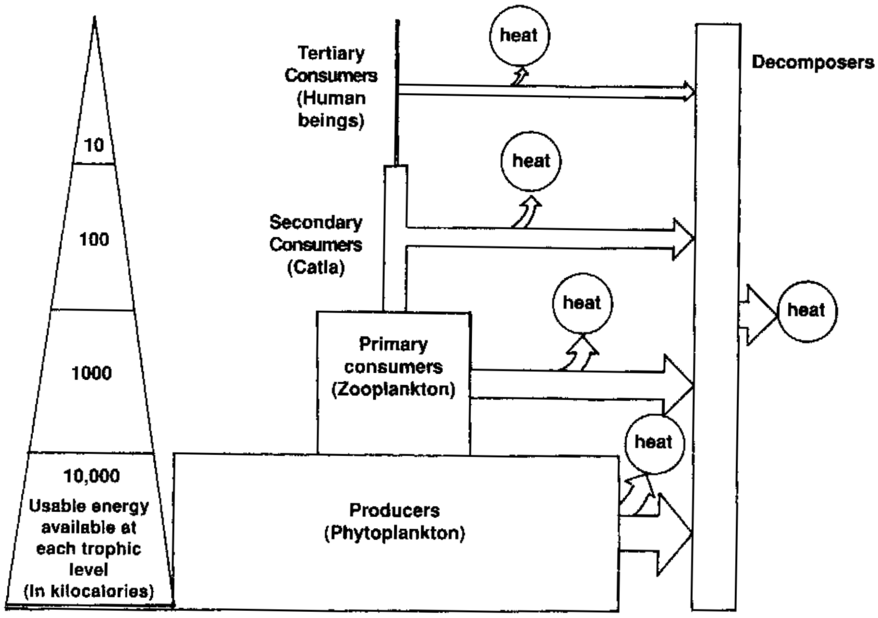
These relationships can be depicted as three types of pyramids, namely, pyramid of numbers, pyramid of biomass and the pyramid of energy. The pyramid of numbers shows the number of individual organisms at each level. The pyramid of biomass shows the total dry weight and other suitable measures of the total amount of living matter, and the pyramid of energy shows the rate of energy flow and/ or productivity at successive trophic levels. The energy pyramid gives the best picture of the overall nature of the ecosystem.

In a food chain or web, biomass (and thus chemical energy) is transferred from one trophic level to another, with some usable energy lost in each transfer. Usable energy is lost at each level mostly as the result of inevitable loss in energy quality imposed by the second law of thermodynamics. The Second Law of Thermodynamics deals with the quality of energy. Unlike the quantity of energy (which is conserved), the quality of energy is not; instead it declines. By quality of energy, we mean the ability of energy to do useful work- that is, to heat, move or change the physical and chemical form of matter.

The percentage of usable energy transferred from one trophic level to the next varies from 5 to 20 per cent (that is a loss of 80 to 95 per cent), depending on the type of organism and the ecosystem.

The following figure illustrates the loss of usable energy (after the use of energy for growth and metabolism) in a simple food chain, assuming a 90 per cent loss with every transfer. This pyramid of energy flow shows that the more the trophic levels or steps in a food chain or web, the greater the cumulative loss of usable energy.

Energy Flow in Ecosystems



ENERGY RELAY

Subject
Science

Group Size
Groups of 10 to 15

Level
Standards 6-8

Materials
Two transparent tumblers or cups of the same size for every 15 students, spoons (one for each player), measuring cylinder

Place
Outdoors

Duration
30 minutes

Objectives

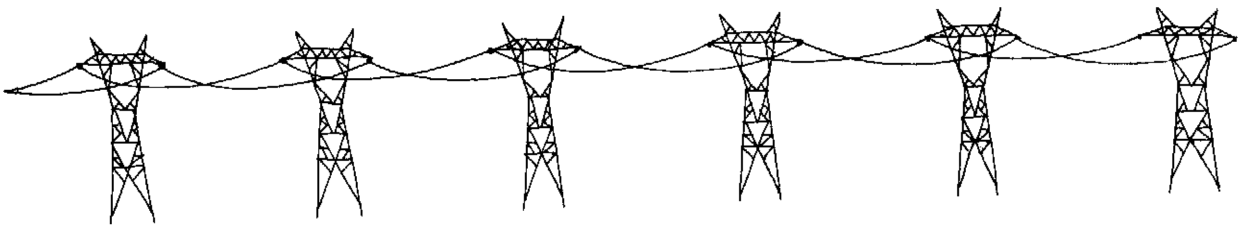
To help students understand that energy is lost as it passes along from the source to the end user and also along a food chain.

Procedure

1. Ask the students to stand in a line.The line should have about fifteen players. (If there are many more than fifteen players, make them stand in two or three lines of fifteen players each).
2. Ask a student to pour 50 ml of water using a measuring cylinder into a cup. Take the cup around so that all the students can see the water level.
3. Give the cup of water and a spoon to the first player in the line. Give an empty cup and a spoon to the last player in the line. Give one spoon to each player in the line.
4. Ask the first player to take a spoonful of water from the cup and transfer it to the second player's spoon. The second player then transfers the water he/ she received to the third player in the line. After this transfer, the second player gets another spoonful of water from the first player. Meanwhile, the third player passes the spoonful of water to the fourth player and so on. The last player receives water in his/ her spoon and empties it into the cup that he/ she holds.
5. After all the water has been emptied into the last player's cup, call the students and ask any one of them to measure, using the measuring cylinder, the amount of water. Show the measuring cylinder to all the players so they can make a note of the amount of water in the last cup.
6. Discuss with the students as to what happened to the missing spoons of water.
7. Explain that each spoon of water represents a quantity of energy and that loss of energy takes place with every transfer.

Extension/ Variation

- Each line of students can be a 'team'. The game can then be an 'Energy Relay Race' with each team trying to complete the transfer of water with the minimum loss within a stipulated time.
- The game can also be played in two rounds, with the players taking care to minimize loss in transfer



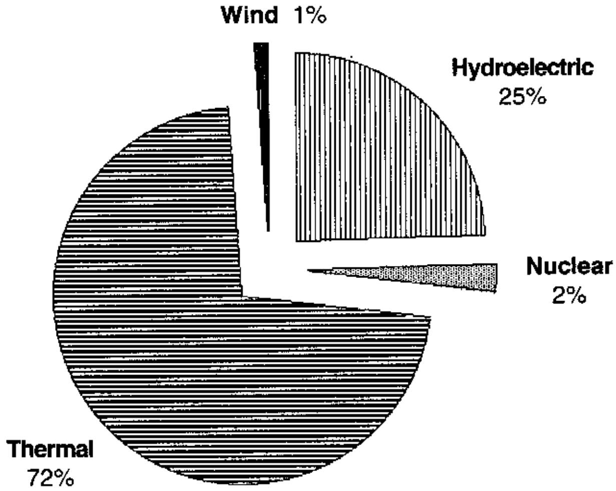
6 INVESTIGATE YOUR POWER HOUSE

BACKGROUND

Electricity is the most convenient and versatile form of energy. It plays a key role in the industrial, agricultural and commercial sectors of economy and is also a crucial source for supplying domestic energy requirements. The demand for it therefore, has been growing at a comparitively fast rate.

In India the major sources of power generation are Thermal, Hydroelectric, Wind and Nuclear. India is expected to depend on coal based thermal power generation for the next few years.

Sources of Power Generation in India



Source : The Citizens' Fifth Report - Part II Statistical Report

Coal Reserves of States in India (million tonnes): January 1999

State	Reserves
Andhra Pradesh	13337.27
Arunachal Pradesh	90.23
Assam	320.21
Bihar	68756.60
Madhya Pradesh	42772.43
Maharashtra	6969.07
Meghalaya	459.43
Nagaland	19.94
Orissa	49061.20
Uttar Pradesh	1061.80
West Bengal	25903.71

Source : TEDDY 1999-2000

INVESTIGATE YOUR POWER HOUSE

Objectives

To help students understand how electricity is produced and how it reaches our homes, through a visit to the local power station.

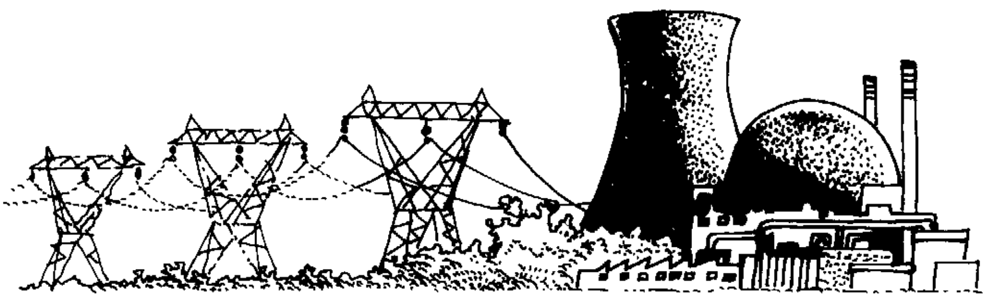
Subject
Science
Group Size
Entire class
Level
Standards 8-10
Materials
Writing materials
Place
Classroom and a visit
Duration
A day visit

Procedure

1. Take the students on a tour to the power company that supplies power to your area.
2. Ask the students to find answers to the following questions during their visit to the power company.
   a. How is energy generated?
   b. What are the environmental impacts of this mode of electricity generation?
   c. Has there been significant changes in the supply/ demand?
   d. How have costs to consumers changed in the last 10 years?
   e. Has the company modified operating methods in the last 10 years to address environmental issues?
   f. Are there any specific programmes/ schemes by the power company to promote energy conservation?
   g. How much are the transmission losses estimated to be? How and where do they occur?
   h. What is the efficiency of generation of power from the source?
3. Ask the students to find out how electricity reaches their home from the power station.

Extension/ Variation

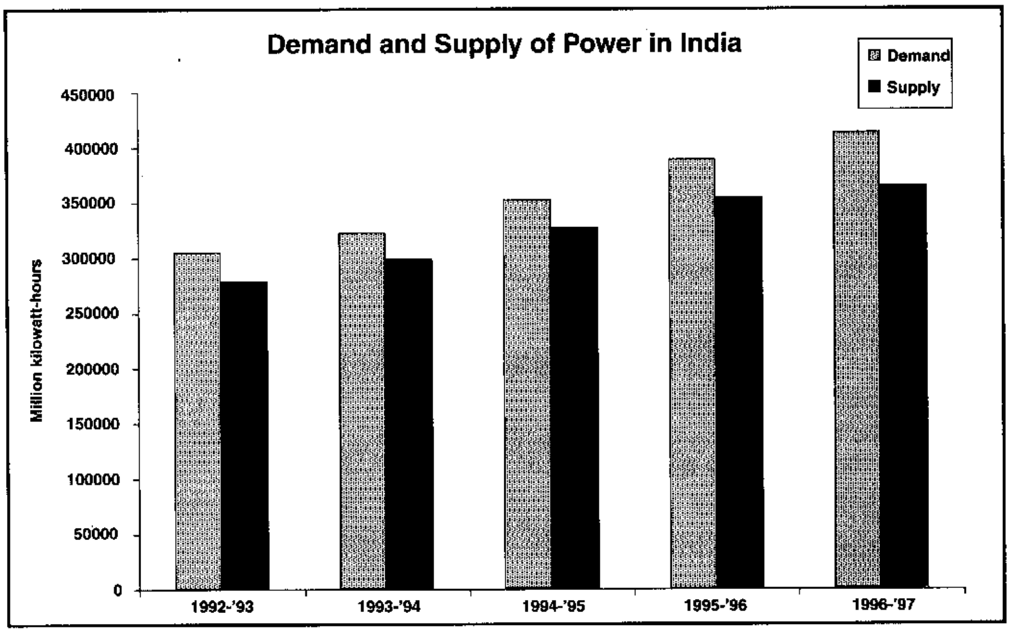
- Ask the students whether there are any alternative sources of power generation possible for their town which could mitigate the negative impacts of the current source.
- Ask the student to bury leaves, banana peels etc., in the ground and watch for chemical changes in them (decaying leaves, a banana peel turning brown). Discuss what happens to plants after they die and fall to the earth. Ask the students how they think coal was formed in the earth. Show a lump of coal to the students. Inform them that it was once a part of a plant.
- Ask the students to describe how coal and petroleum were formed millions of years ago.
- Ask the students to write a paragraph and illustrate "The story of my life" as told by a lump of coal.



7 A POWER PLANT FOR RAMPUR

BACKGROUND

In India, the monthly per capita consumption of electricity in the rural sector has increased from 1.30 kWh in 1987-'88 to 2.27 kWh in 1993-'94; while in the urban sector, the per capita consumption has increased from 7.18 kWh to 9.67 kWh during the same period. The demand for electricity has gone up by approximately one and a half times in a period of 6 years from 1991-'92 to 1996-'97.



Source : The Citizens' Fifth Report - Part II Statistical Report

Given the negative environmental impacts of conventional ways of generating energy, there is a need to shift to renewable energy technologies. India is well endowed with renewable energy sources. The exploitation of this potential depends upon it being acceptable in planning and environment terms, its cost, and the electricity supply network being able to accept its output. The technologies most possible in India are wind, hydel, farm wastes, solar and wave energy.

Renewable Energy Potential and Achievements in India

Source/Technology	Units	Potential	Achievements
Wind Power	megawatts	20,000	900.00
Small Hydro Power	megawatts	10,000	141.00
Biomass Power	megawatts	17,000	83.00
Solar Photovoltaic Power	megawatts/ sq.km.	28	20.00
Urban and Municipal Wastes	megawatts	1,700	93.75
Biogas Plants	millions	12	2.50

Source : The Citizens' Fifth Report - Part II Statistical Report

A POWER PLANT FOR RAMPUR

Objectives

To enable students to
- Identify the advantages and disadvantages of four common sources of electricity viz., Thermal, Nuclear, Hydroelectric and Solar.
- Weigh alternatives for eliminating a shortage of electricity.
- List the costs and benefits of energy conservation.

Subject
Science, Social Studies, Language

Group Size
Groups of 6

Level
Standards 8-10

Materials
Writing materials

Place
Inside the classroom

Duration
45 minutes

Procedure

1. Divide the class into groups of 6 students each.
2. Photocopy or write each role on a separate slip of paper. Assign the six roles to the members in each group and distribute their roles to them.
3. If there are some extra students, ask them to act as "observers" or as "reporters". Ask the students to "get into" the character's role. Emphasize that the role-play is a serious session. Tell them not to share their roles with others in the group.
4. Read out the enclosed "Case of Rampur" and ask the students to get into their roles and discuss and evaluate each source, and the alternative options based on the criteria they think are important. Tell them they have half an hour for the discussion.
5. Ask them to come to a decision, as a group, after considering the following factors:
   - Sustainability of the source
   - Safety risk of the source
   - Pollution
   - Cost–both initial and recurring cost
   - Renewability
   - Ability to meet the increasing demand
6. After the role-play, which solution does each group think would be best for Rampur? Ask them to explain their decision.
7. Ask the observers/ reporters if any, to report their observations on the process.

Extension/ Variation

- Ask the students the following key questions:
  a. What are the advantages of each source of electricity? What are the disadvantages?
  b. What are the advantages and disadvantages of conservation as an alternative to building a new power plant? Some people argue that conservation is a "free" source of energy. Do the students agree?

A POWER PLANT FOR RAMPUR

THE CASE OF RAMPUR

You are residents of a state where "Rampur", a booming industrial locality is situated. You must, in the capacity of the roles assigned to you, evaluate several proposals for dealing with a growing shortage of electricity.

THE SCENARIO

"Rampur" is enjoying a period of economic growth that most places can only dream about. Rampur has grown from a sleepy little rural locality to a booming place with plenty of jobs and high standards of living.

Rampur luckily, has avoided problems like crime and pollution that plague many other communities during their boom periods. It has become a place where people want to live and where businesses want to come. As a result, the population has increased fivefold during the last 25 years. Yet electricity is produced in a power plant built in 1949 designed for a much smaller population. During the heat wave last summer, many air-conditioners, air coolers and refrigerators were turned on and power shortages occurred all over the place. It is feared that the situation will get worse in the future.

The Chief Minister of the state has called for a cabinet meeting with all members concerned, and she has also invited leading industrialists and research scientists from across the state, working on various aspects of energy, for technical assistance and clarifications. Through this meeting, she plans to decide on the type of energy source to depend on for generating further power for Rampur.

A POWER PLANT FOR RAMPUR

THE ROLES

(Write each out on a separate slip of paper and give it to the student to whom the role has been assigned.)

CHIEF MINISTER

You are a sincere and shrewd politician. You wish to help Rampur to develop further, by setting up a power plant. More so because you have invested a large share of your earnings on industries in Rampur. You are also concerned about the environment in general, and that of Rampur in particular. The place has a large beautiful Revati Talav (lake) which has a lot of migratory birds visiting it during various seasons.

MINISTER FOR ENERGY

You are a sincere minister who wants development to occur in Rampur. By setting up a large power plant, you plan to increase your popularity in the state. You want to ensure that you get re-elected in the elections scheduled in the coming year. You are of the opinion that setting up a large dam across the River Nandhini that flows close to Rampur is a good option. (Nandhini river is a large river which is a major source for irrigation. It becomes dry during severe summer). You have plans to give employment to people who get displaced, in industries that would experience growth and the new industries that would be set up, or give them land to take up agricultural activities in the nearby villages. Setting up of a large dam would ensure your name get popularized and it will boost irrigation to farmers during summer.

MINISTER OF INDUSTRIES AND MINES

You are a popular politician, who would like to take up the Chief Minister's chair and are aiming for more popularity in the state. You are not concerned about the source of power. Your only concern is that the proposed plan should provide maximum employment to people around, since neither has any new industry or mine been set up during your tenure as Minister of Industries and Mines, nor were you able to introduce any new tax rebates for industries. You are worried that you are slowly losing your popularity with industrialists, as power needed for industries is not available in sufficient quantity.

LEADING INDUSTRIALIST

You are one of the leading industrialists in the country. You are totally against the idea of conservation. In your opinion, industries need more energy. According to you, even a little conservation in the industrial sector means making a sacrifice, in terms of quality and the production rate. This means reducing the growth rate and progress of Rampur and the state.

During your recent visit abroad, you have observed a large number of nuclear power plants which do not let out any smoke as the present thermal power plant in Rampur does. You strongly feel your state should also go for a nuclear power plant, as it is least polluting to the environment.

A POWER PLANT FOR RAMPUR

ENVIRONMENTALIST

You are a very concerned environmentalist. You feel that with more development, Rampur's environment is getting increasingly degraded. The air that people breathe during peak hours in the place is equivalent to smoking a dozen cigarettes through the day! The air has become stale and the birds that visited the beautiful Revati Talav (lake) nearby are slowly decreasing in number. You are of the opinion that actually, very little power is needed for the sustainable growth of the place. You are of the strong opinion that setting up of solar power generating units in the vast wasteland nearby, coupled with conservation measures by one and all, could easily solve the current crisis.

RESEARCH SCIENTIST

You are of the opinion that setting up a new power plant could be postponed. You are of the strong opinion that conservation can stretch the energy resources, reducing or eliminating the need for additional energy generating capacity. However, this could happen only if people in all the sectors — industrialists, farmers and the common public — adopt energy conservation measures. You know that average efficiency of power plants is only44 per cent and transmission losses as high as 22 per cent, you feel that Ministry of Power should focus on ways to reduce these. Also you feel that industries by using more efficient processes and technologies can cut down energy use. You are of the opinion that people are getting too Westernized by blindly imitating the western power-intensive culture. You are aware of the advantages and disadvantages of each of the sources.

Coal — The main advantage of coal is relative abundance, more than any other source, with a supply for more than 50 years at today's rate of use. The primary disadvantages are the dangerous nature of coal mining, pollution from ash, and sulphur dioxide emissions, which can cause acid rain.

Nuclear — The advantages include the potential to produce energy with low fuel costs and no air pollution. The disadvantages are the lack of foolproof technical know-how in operation, exposure to radiation to workers in nuclear power plants, disposal problem with the radioactive waste and the possibility of a catastrophic accident.

Solar — Advantages include low operational costs and no pollution. But solar power is land-intensive with high initial expense and needs some kind of storage facility, for the lack of sunlight at night. Further, output depends on the weather, requiring sunny days.

Hydroelectric Power — The principal advantages are that it is pollution free, renewable and relatively cheap. On the other hand, making dams is land-intensive, involves very high initial expense, requires abundant supply of water (which is seasonal in most parts of the country), disturbs the natural ecosystem, is highly prone to natural disasters like earthquakes, etc., causes waterlogging in areas nearby, is subject to problem of siltation, and involves resettlement of many people in the submergence area of the dam.

OBSERVERS/ REPORTERS

You are designated as an Observer/ Reporter for this meeting by the Chief Minister. You are supposed to observe and record all actions and points that help the group to reach the solution during the discussion. You should not voice your opinion or make comments that would distract the others.

ENERGY FROM WIND 8

BACKGROUND

Moving air is called wind. Wind moves from a high-pressure area to a low-pressure area. The pressure difference is created when the sun heats the air more in one place than the other. Thus the energy from the wind is a form of solar energy. We know that the faster the wind blows, more power is available. Though wind is invisible, its effects are quite apparent.

The wind's energy has been used for various purposes throughout history. Even as early as 400 B.C., there is a reference to windmills in Kautilya's Arthshastra. The Dutch windmills were used to grind grain and pump water much before we used coal or oil.

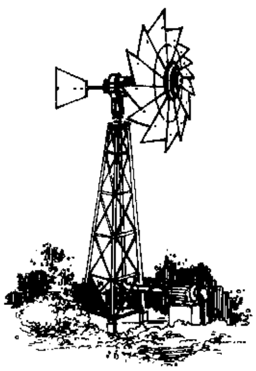
Wind Power Installed Capacity (MW) : 30 September 1998

State	Capacity of Demonstration Projects (MW)	Capacity of Private Sector Projects (MW)	Total Capacity (MW)
Andhra Pradesh	3.05	54.74	57.79
Gujarat	17.35	149.56	166.91
Karnataka	2.58	15.69	18.27
Kerala	2.02	-	2.02
Madhya Pradesh	0.59	17.86	18.45
Maharashtra	4.60	3.52	8.12
Orissa	1.10	-	1.10
Tamil Nadu	19.36	699.52	718.88
Others	0.47	-	0.47
Total	51.11	940.88	991.99

Source : TEDDY : 1999-2000

Today, not only do wind turbines provide power in India, but they also energize thousands of rural residences around the world. In India, potential contribution of wind to energy supply is 20,000 MW. Wind power can provide potentially more renewable energy in India than any other source. At present, a very small part of the energy is derived from wind, but many new schemes are now being proposed.

There is a renewed interest in using wind for mechanical power applications such as pumping water, operating refrigeration compressors and heating water with mechanical friction.



ENERGY FROM WIND

Objectives

To help students investigate how wind moves a windmill, by performing a simple experiment.

Subject
Science
Group Size
Groups of 2 to 3
Level
Standards 6-8
Materials
10 cm x 10 cm square of thin card for each group, pins
Place
Inside the classroom
Duration
45 minutes

Procedure

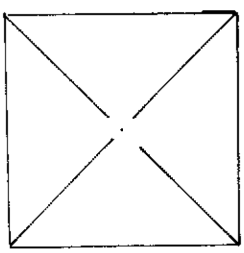
1. Ask the students to prepare a simple wind wheel following the instructions given below (refer box "Making a Wind Wheel").
2. Ask the students to move it by different methods such as blowing on it, running with it or placing it in front of a fan.
3. Ask them to observe that the faster the air moves, the faster the wind wheel rotates. Also, the wind wheel rotates faster when it faces the moving air directly.
4. Through discussion, help the students deduce that energy of the moving air makes the wind wheel rotate. Discuss the uses to which this can be put. Explain how this helps to move a turbine and generate electricty.
5. Discuss the use of wind energy and the potential of increasing the exploitation of wind energy in India, especially in your state.

Extension/ Variation

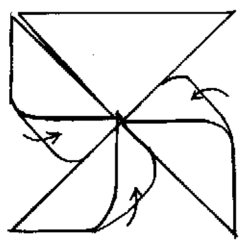
- Explain how this principle is utilized in wind mills.
- Ask the students to discuss what could be the advantages and disadvantages of wind power.

Making a Wind Wheel

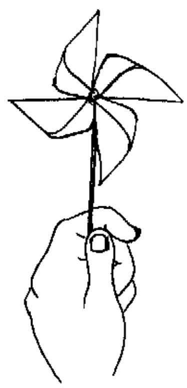
1. Give every group a 10 cm x 10 cm square of thin card.



2. Ask the students to draw diagonals and to make 4 holes on the four corners and one hole in the centre, with a pin.



3. Ask them to cut along the diagonals almost to the centre. Ask them to bring the corners of the windmill to the centre.



4. Drive a pin through the holes into the card as shown in the figure above.

5. Ask the students to try different lengths and shapes and different angles of blade.

A BOX OF SUNSHINE 9

BACKGROUND

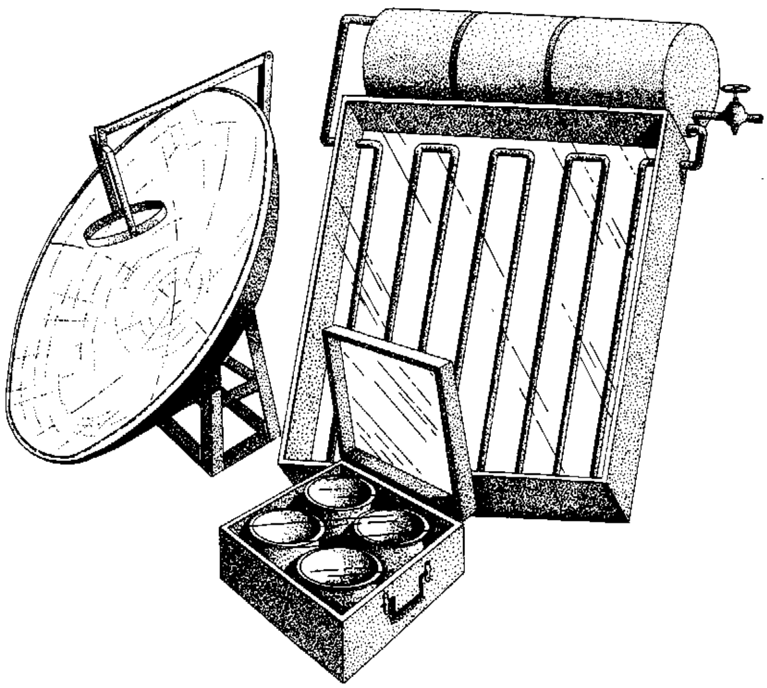
India receives 5000 trillion kWh of solar radiation per year. In most parts of the country, out of the 365 days, 300 are sunny days. With the sunshine India receives, it is possible to generate 20MW solar power per square kilometer of land. Solar energy has been in use in India from time immemorial for several domestic, agricultural and manufacturing purposes, including preservation, protection, and processing of foods, e.g., preserving pickles and spices, and drying clothes.

In India, a major part of the energy in the household sector is used for cooking. It has been estimated that within the household sector, cooking accounts for over 90 per cent of the energy consumed. Therefore, it is important to consider conservation in this sector. This is where solar energy can come in useful.

In recent times, in India as the world over, there has been an increased thrust on research and development on technologies and devices to harness the sun's energy efficiently. The solar cooker is one such device. This works on the principle of Greenhouse Effect. In a solar cooker, a blackened sheet is placed inside an insulated box and the open face of the box is covered with a glass sheet. The inner walls are painted black to maximize the absorption of heat and minimize heat losses due to reflection. When such a solar cooker is kept in the sunlight, the inner surfaces heat up after absorbing solar energy. As a result, these surfaces start radiating heat in the form of infrared radiation. But the glass sheet above prevents the radiation from escaping and thus helps in retaining the heat inside the box.

A solar cooker has the advantage that it helps to reduce the consumption of conventional fuel and electrical energy. It does not pollute the environment. As it is a slow cooking device, it preserves the nutritional value of the food. It is also easy to operate and helps save money.

As of 1998, there were over 4,56,674 solar cookers in India. While this is a good beginning, there is a great scope for improvement.



A BOX OF SUNSHINE

Objectives

To enable students to
- Construct a lightweight portable solar cooker.
- List the advantages and disadvantages of cooking food in a solar cooker.
- Cook some simple dishes suggested in "Solar Recipes", using the solar cooker.

Subject
Science, Mathematics
Group Size
Whole class or groups of about 10
Level
Standards 6-8
Materials
See box "Making a Solar Cooker"
Place
Inside the classroom and outside
Duration
30 minutes to 1 hour, plus time for cooking

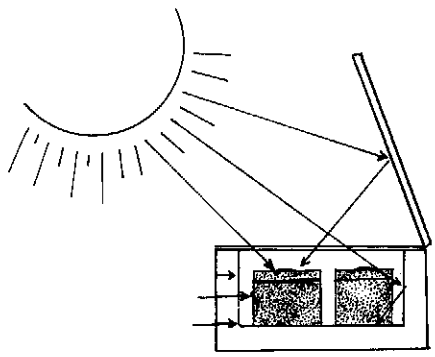
Procedure

1. Ask the students to find the name of a kitchen appliance which fits the following description:
   "Easy to use, produces no smoke, can be used many months of the year, requires no fuel or chemicals, and costs nothing to operate".
2. Discuss all the answers given, and how they may not fit every characteristic in the description. The correct answer is of course, a solar cooker.
3. Ask the students to build a solar cooker according to the instructions given in the box "Making a Solar Cooker".
4. Discuss how a solar cooker can prepare food efficiently and at the same time promote good health and wise energy use.
5. Ask them to cook any one of the dishes listed in the "Solar Recipes" using the solar cooker.

Extension/ Variation

- Ask the students to list advantages and disadvantages of using a solar cooker.
- Ask each of the students to describe their experience with the solar cooker to their parents, and discuss with their parents the possibility of using a solar cooker at home.

Making a Solar Cooker



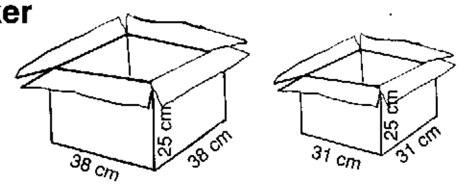
Materials Needed

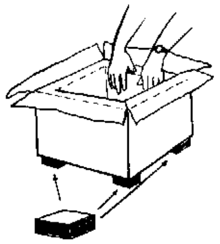
Two cardboard cartons (The first box should be approximately 38 cm x 38 cm, and of height 25 cm. The second box should be approximately 31 cm x 31 cm and about 3 cm shorter than the first box.), corrugated sheet, one sheet of cardboard to make the reflector (approximately 43 cm x 43 cm), silver foil (one roll), dull black paper, flower clips, thick transparent plastic sheet, scotch tape.

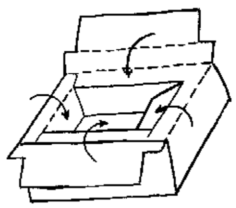
A BOX OF SUNSHINE

Making a Solar Cooker

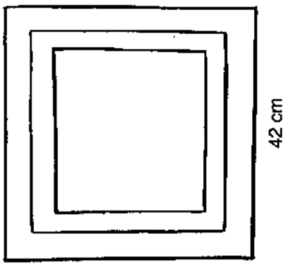
This model of solar cooker is based on having one box inside the other. The larger box of dimensions 38 cm x 38 cm x 25 cm will serve as the outer box, and the box of dimensions 31cm x 31cm x 25 cm will serve as the inner box.

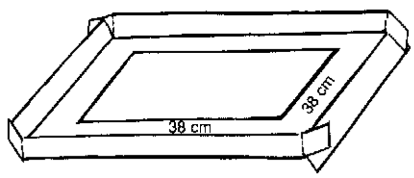


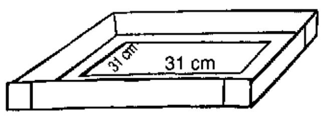




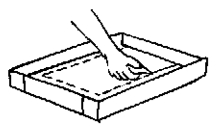
1. Paste silver foil on all the inside surfaces of the larger box.
2. Also paste foil on the inside and outside of the flaps (lid) of the outer box.
3. Paste black paper on the bottom of the inner box. On all the other inner surfaces of this box, paste silver foil.
4. Cut off the flaps of the inner box.
5. Make four 'legs' for the inner box by folding 4 pieces of corrugated sheet and pasting near the four corners at the bottom of the box. The height of the legs should be about 3 cm.
6. Place the smaller box inside the larger one. If the height of the inner box is more than that of the outer box, trim as necessary to bring them to the same height.
7. Fold the flaps of the outer box such that they cover the gap between the outer and inner boxes and can be folded down 2 cm into the inner box.
8. Hold tight and tape down securely, so that there is no gap. If there is extra length, trim it.

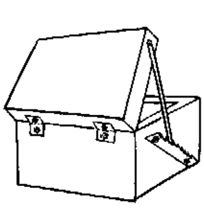




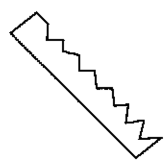


9. Now, cut a piece of corrugated sheet (approximately 42 cm x 42 cm) large enough to make a tight fitting lid for the outer box (38 cm x 38 cm).
10. Cut away a window of the size of the inner box (31 cm x 31 cm) from this piece of the sheet. Tightly tape a piece of thick transparent plastic over this window.
11. Paste silver foil on the inside of the lid (except where there is plastic).
12. Now fold and tape the edges of the corrugated sheet to make a tight fitting lid.





13. Take a piece of cardboard of 43 cm x 43 cm size to make a reflector. Paste silver foil on the inside.
14. Make hinges of cardboard and attach with flower clips to the lid and the relector.
15. Take a piece of cardboard of 15 cm x 12 cm and make serrations as shown.
16. Tape securely, at the angle shown, to the outside of the box.
17. Make a firm prop using a folded piece of cardboard or a stick. The prop should be long enough to hold up the reflector at 45°.



A BOX OF SUNSHINE

Setting up the Box

1. Place the items to be cooked in an aluminium container with a lid, painted black on the outside.
2. Place the box with the necessary ingredients in the inner box.
3. After this, shut the solar box tightly with the lid.
4. Place the cooker in full sunlight, on a dry surface away from tall objects like walls, trees etc., that could cast a shadow.
5. Adjust the box to face the sun (towards the east in the morning).
6. Adjust the reflector with the help of the prop until the reflected sun's rays light up the inside bottom of the cooker.
7. Move the box gradually to face the sun along with the sun's movement towards west through the day.

SOLAR RECIPES

ALU CHAAT

Cooking Time	4 to 5 hours
Ingredients	Potatoes 2 to 3, green chillies (chopped) - 1, ginger (grated) - 1/4 teaspoon, coriander leaves (chopped) - 1 teaspoon, black pepper powder - 1/4 teaspoon, Amchur Powder - 1/4 teaspoon, chaat masala - 1/4 teaspoon, lemon juice -1 teaspoon and salt to taste.
Method	Wash the potatoes. Cut them into halves and place them in the can with some hot water in the solar cooker. Once boiled (approximately 3 hours in the model cooker made by you), remove the skins and mash the potatoes. To the mashed potatoes add salt, the finely chopped chilli and grated ginger. Roll the mixture into small balls. Mix the powdered masalas in the lemon juice and sprinkle over the potato balls. Garnish with coriander leaves and serve.

CHUNDA

Cooking Time	3 to 5 hours
Ingredients	Rajapuri Green Mangoes - 2 (medium size), sugar -3 cups, turmeric powder - 1/2 teaspoon, chilli powder - 1 teaspoon, cumin seed powder - 1/2 teaspoon, asafoetida - 1 pinch and salt to taste.
Method	Wash peel and grate the mangoes. Add salt and sugar to the grated mangoes. Mix well and leave aside for a few hours. Put the mixture in an open steel container and place it inside the solar cooker. When done, set aside to cool. (Take a little mixture between your thumb and the fore finger and part your fingers. If you get a thread like consistency, you will know it is done.) Then add the chilli, turmeric and cumin seed powders and asafoetida. Mix well and store in an air tight bottle container.

BREAD PUDDING

Cooking Time	3 to 4 hours
Ingredients	Milk - 1 cup, egg -1, bread - 2 slices, sugar - 4 tablespoons, chocolate powder - 1 teaspoon, vanilla essence - 2 drops.
Method	Soak the bread in milk for about 20 minutes. Add chocolate powder, sugar and vanilla essence to the egg and beat well. Mix the egg with the soaked bread. Put the mixture in a container, close the lid and place it in the solar cooker for 1 - 2 hours.

CHECK YOUR ENERGY IQ ! 10

BACKGROUND

A most cost-effective and sensible approach to today's energy problems is practicing energy conservation. Each of us must realize that we cannot continue using energy at our present rate of consumption. We must look for ways to decrease our energy use. We can achieve this only by being good consumers and changing those of our habits which waste energy. Areas where each of us can have an impact on conserving energy are: use of heating and cooling devices; lighting; use of appliances in our homes and work places; wise and proper use of transportation systems; and cooking practices.

A few steps that can help save energy include;

- Switch off lights and fans whenever you leave a room.
- Do not leave a refrigerator open when you drink water.
- In winters dress in warm, layered clothing, and in summers dress in light coloured and loose fitting clothing.
- Defrost your refrigerator regularly and do not let the frost accumulate.
- Avoid using a lift for going down the stairs.
- Avoid using personal vehicles. Use public transport whenever possible and walk or cycle for short distances.

The Lamp for the Future

Features	**Compact Fluorescent Light Bulb**	**Incandescent Bulb**
Life	5000 hrs.	800 hrs.
Consumption	15 W	75 W
Consumption in Watts	15W x 5000 hrs. = 75,000 W	75 W x 5000 hrs = 3,75,000 W
Consumption in kWh (unit)	75 kWh	375kWh
Cost of Electricity @ Rs. 4. 50/- per kWh (unit)	75 x 4.50 = Rs. 337. 50/-	375 x 4.50 = Rs. 1,687. 50/-
Cost of Lamp	Rs. 400/-	Rs. 60/- (10 x 6)*
Total Cost	Rs. 737. 50/-	Rs. 1747.50/-

Total Saving by using a compact fluorescent light bulb is (1747. 50 - 737. 50) = Rs. 1010/-.

*Average burning life of an incandescent bulb is around 800 hrs. whereas for a compact fluorescent light bulb it is 5000 hrs. Hence, one compact fluorescent light bulb's life is equal to that 6 incandescent bulbs.

CHECK YOUR ENERGY IQ !

Objectives

To help students
- Rate their knowledge and behaviour with regard to energy use and energy wastage in their daily life.
- Correct some commonly prevalent misconceptions regarding energy use.
- Understand that even their small actions can help conserve energy.

Subject
Science
Group Size
Entire class
Level
Standards 6-8
Materials
Writing Materials
Place
Inside the classroom
Duration
30 minutes

Procedure

1. Read out the questions from the enclosed "Energy Questions" and ask the students to note down whether, according to them, each statement is "True" or "False".
2. Once they finish answering all the questions, give the answers, explaining in detail the scientific principles associated with each answer.
3. Help the students rate themselves on their awareness and behaviour related to energy, based on the scoring sheet.

THE ENERGY QUESTIONS

a. On winter afternoons, we should always keep the curtains on all west-facing windows closed, to block out the cool breeze from entering.

b. We should allow a lot of frost to get deposited in the freezer compartment in our refrigerators, because cold frost cools the air inside the refrigerator faster, thus saving energy.

c. On hot summer days, it is a good idea to get that little extra cooling into the room by opening the refrigerator.

d. The freezer compartment of the refrigerator functions most effectively when it is half or three-fourth full.

e. Refrigerators are designed to accept frequent and long door openings without increased operating costs.

f. Small appliances such as hand mixers, chutney grinders and juicers generally use less energy for specific jobs than a food processor.

g. Fluorescent light bulbs and incandescent bulbs of the same wattage produce the same amount of light.

h. We will save energy by doing several small loads of wash in the washing machine every day, rather than one large one on the weekend.

i. Driving faster uses less energy because operating time is reduced.

j. It takes less fuel to restart a vehicle than to idle it for more than 60seconds.

k. The less air in the tyre, the less fuel will the vehicle burn.

l. If the flame of the gas stove is blue, it is not operating properly.

CHECK YOUR ENERGY IQ !

ANSWERS

a. **False.** The energy savings gained by keeping the curtains closed depends on the time of the year. In winter, keep the curtains open and let the sun's rays into the room for extra warmth.

b. **False.** A frosty refrigerator uses more energy than a defrosted refrigerator. Frost acts as an insulator. This is the principle on which igloos are based. Don't let frost accumulate to more than one-fourth of an inch.

c. **False.** Using your refrigerator is a very costly way to cool your room. When left open for long periods of time, the refrigerator will in fact make the room warmer than cooler!

d. **False.** The freezer is most efficient when filled to capacity.

e. **False.** It costs money and energy every time a refrigerator door is opened.

f. **True.** Small appliances like hand mixers, chutney grinders, etc., often use less energy than a food processor. They are designed to do specific jobs, making the work easier and usually quicker.

g. **False.** Fluorescent and incandescent bulbs of the same wattage do not produce the same amount of light. Fluorescent light bulbs produce about three and a half times more light than incandescent bulbs of the same wattage.

h. **False.** A large-capacity washing machine saves energy by handling in one load, what the same machine would, when used in two or more loads. It is better to collect clothes for one full-load wash than do small loads of wash every day with fewer clothes.

i. **False.** All vehicles have an optimum speed at which they give maximum mileage. Refer to your vehicle's booklet to find its optimum range. For example, two-wheeler have an optimum speed range between 40 and 50 km/ hr. This is the range in which they are most fuel-efficient. Also, drive the vehicle steadily at the optimum speed. Do not speed and brake often.

j. **True.** It takes less fuel to restart than to let a vehicle idle for more than 60 seconds.

k. **False.** Lower tyre pressure increases fuel consumption and also decreases the tyre life. Check air pressure in your tyres regularly and ensure that it is as per specifications.

l. **False.** If the flame on your gas is blue, it is operating correctly. If the flame has yellow traces, the burners have become clogged and should be cleaned.

SCORING SHEET

Check your answers and evaluate yourself on the following grades!

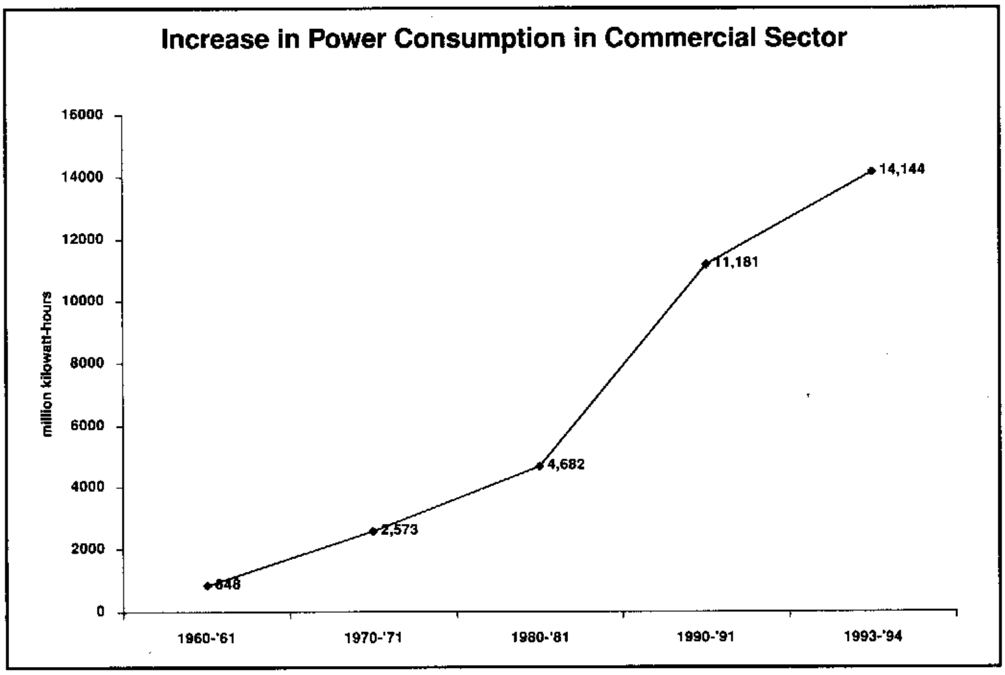
1.	9-12	Correct answers	EXCELLENT! High energy IQ
2.	6-8	Correct answers	GREAT! Above average Energy IQ
3.	3-5	Correct answers	NOT BAD! You still need to learn more about energy conservation.
4.	0-3	Correct answers	OH NO! Study the answers again. You are probably throwing money away needlessly.

11 HOW MUCH MY HABITS COST ME

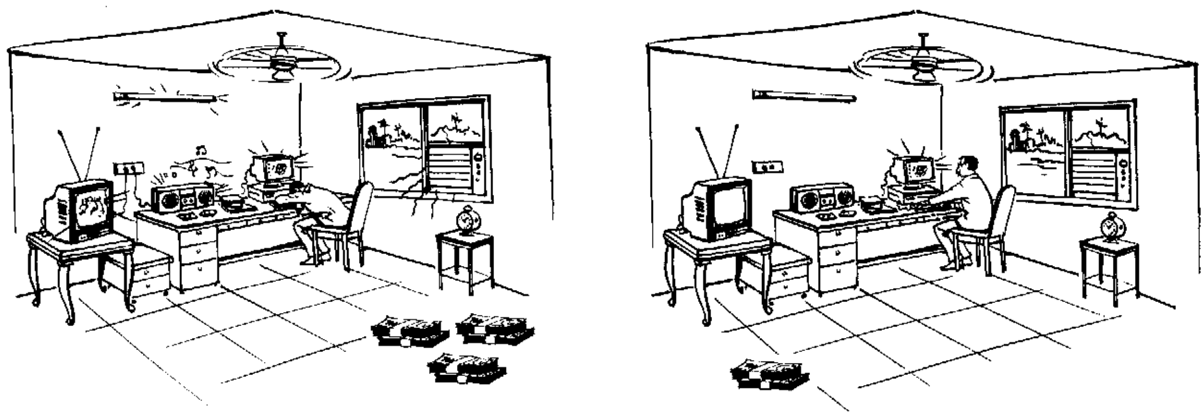
BACKGROUND

Energy consumption in India is increasing rapidly. For instance, the commercial energy consumption increased from 130.7 mtoe in 1991-'92 to 176.08 mtoe in 1997-'98.

In this situation, conservation of energy is an important value that we need to practice in our day-to-day life. Another important factor we need to become aware of is that while most people are careful in their own homes, there is a tendency to be careless about energy conservation at other places like schools, institutions and offices, probably because we feel that we do not have to pay for the energy consumed. But someone is paying! Moreover, all of us have to pay for energy wasted in terms of environmental costs – the natural resources used and the pollution created. So, the perception of "energy for free" has to change, and the change needs to begin with today's students, who are tomorrow's decision-makers.



Source : The Citizens' Fifth Report - Part II Statistical Report:



HOW MUCH MY HABITS COST ME

Objectives

To help students understand the environmental and monetary costs of energy-related daily habits.

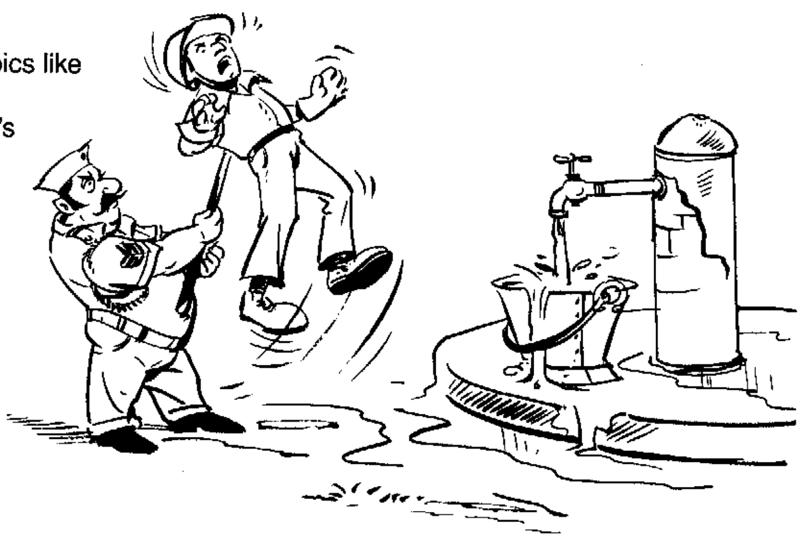
Subject
Science, Social Studies
Group Size
Entire Class
Level
Standards 7-9
Materials
Two envelopes per student–one marked "A" and one marked "B", 40 matchsticks per student
Place
Inside the clsssroom
Duration
30 minutes

Procedure

1. Give each student two envelopes, one labelled, "A" and another "B".
2. Give each student 40 matchsticks, or ask them to collect 40 twigs from the school ground.
3. Tell them to consider the matchsticks or twigs as "play money" valued at Rs. 5/- each.
4. Tell the students that you are going to ask them several questions one by one. After each question, explain to the students that depending on their answer, you will give instructions on whether they should put money in the "A" envelope or the "B" envelope.
5. Tell the students that this game will help them to understand for themselves how much impact they have on the environment, so they should try to answer the questions sincerely, after sufficient thought.
6. Ask the students the "My Habits Cost" questions given on page 40. Follow each question with instructions to the students as to whether they should put their money in the "A" envelope or in the "B" envelope, and how much.
7. After asking all the questions and giving instructions, ask the students to count the money in each envelope.
8. Tell them that the "A" envelope represents the money saved by avoiding wastage of energy and "B" is the money spent on energy. Thus the students with more money in the "A" envelope are using energy wisely and benefitting both the environment and their pockets.
9. Explain to the students the "Why" of the answers (refer "Reasoning Sheet" given on page 41), for them to understand their energy-wasting habits and how they could save more for themselves.

Extension/ Variation

- Select questions on a variety of topics like water, energy, etc., to give a wider understanding of how an individual's actions have an impact on the environment.



HOW MUCH MY HABITS COST ME

MY HABITS COST

a. Do you play more than one TV/ Music system in your house simultaneously at any time?
Yes. Pay the "B" envelope Rs. 20/- for each appliance, from the second appliance onwards.
No. Pay the "A" envelope Rs. 10/-.

b. Do you turn off the lights every time you leave your room?
Yes. Pay the "A" envelope Rs. 10/-.
No. Pay the "B" envelope Rs. 20/-.

c. Do you use a hair dryer in summer?
Yes. Pay the "B" envelope Rs. 20/- for every time you use it in a week.
No. Pay the "A" envelope Rs. 5/-.

d. Do you play video games?
Yes. Pay the "B" envelope Rs. 10/-.
No. Pay the "A" envelope Rs. 5/-.

e. Do you walk or cycle short distances rather than depending on a petrol/ diesel vehicle?
Yes. Pay the "A" envelope Rs. 5/-.
No. Pay the "B" envelope Rs. 20/-.

f. Do you eat your breakfast and dinner together with all the members in the family?
Yes. Pay the "A" envelope Rs. 5/-.
No. Pay the "B" envelope Rs. 10/-.

g. Do you travel by private vehicle (scooter or car) for reaching the school?
Yes. Pay the "B" envelope Rs. 20/-.
No. Pay the "A" envelope Rs. 10/-.

h. Do you keep the refrigerator door open while drinking water?
Yes. Pay the "B" envelope Rs. 10/-.
No. Pay the "A" envelope Rs. 5/-.

i. Do you operate appliances on battery instead of directly using the mains?
Yes. Pay the "B" envelope Rs. 20/-.
No. Pay the "A" envelope Rs. 5/-.

j. Do you use the lift for going downstairs?
Yes. Pay the "B" envelope Rs. 20/-.
No. Pay the "A" envelope Rs. 10/-.

k. Do you use natural light during daytime for activities like reading, writing, etc.?
Yes. Pay the "A" envelope Rs. 10/-.
No. Pay the "B" envelope Rs. 20/-.

l. Do you use incandescent bulbs at home?
Yes. Pay the "B" envelope Rs. 10/- per bulb used.
No. Pay the "A" envelope Rs. 5/- per fluorescent light bulb used at home.

HOW MUCH MY HABITS COST ME

REASONING SHEET

a. A TV/ Music system consumes approximately 30 units of electricity every month, when used for one hour every day. You cannot enjoy two or more together. So it is a waste keeping more than one on.

b. Domestic light bulbs consume electricity ranging from 40 W to 100 W. On an average, almost 5 to 10 units (kWh) of useful energy is wasted every month in a home, by not switching off the lights when not needed.

c. A hair dryer consumes approximately 1 unit of electricity every time it is used. In our country, it is definitely not needed in summer.

d. Electronic video games not only consume electric power, they also make one sedentary, leading to health problems.

e. Cycling and walking are good for health. Also for this mode of transport, we do not need fossil fuel.

f. 50 per cent of energy consumed in India is used for cooking. Often in our homes, the food is reheated every time a person sits down to eat. Quite a lot of fuel is spent in this reheating. Moreover, every time the food is reheated, nutritive value of the food is lost. Eating together means less energy spent.

g. Most cars travel about 10 to 12 kilometres per litre. Assuming that 4 persons travel in a car, that makes 40 to 48 person kilometres. On the other hand public transport vehicles like buses, trains etc., travel 50 to 200 person kilometres for the same quantity of fuel.

h. A refrigerator consumes approximately 6 units of electricity for every hour its condenser works. Every time a refrigerator is opened, the cool air from the refrigerator moves out and the warm air from outside moves in. This means the condenser has to work longer.

i. The energy spent to manufacture a battery cell is more than the energy it supplies. Also, when disposed after use, the chemicals in these cells leak out and pollute the environment.

j. A lift is one of the high energy consuming devices often used by individuals. Walking downstairs is good exercise, so should be preferred.

K. In tropical countries like ours, abundant daylight is available throughout the year. Moreover, it is available free and does not use any of the earth's resources.

l. A 75 W incandescent bulb (filament bulb) consumes 7.5 units for running 100 hours, while a 15 W compact fluorescent light bulb (which gives the same amount of light as a 75 watt bulb) consumes only 1.5 units.

12 WHAT AM I PAYING?

BACKGROUND

There are several ways to look at how much things cost us. In dealing with expenses, most people think of the cost of an item solely as the amount marked on the price tag, in terms of rupees and paise. In fact, this is only one unit in which costs can be expressed. We could also think of expressing the cost of an item as the amount of time that one must work to earn enough money to pay for the goods and services needed or desired.

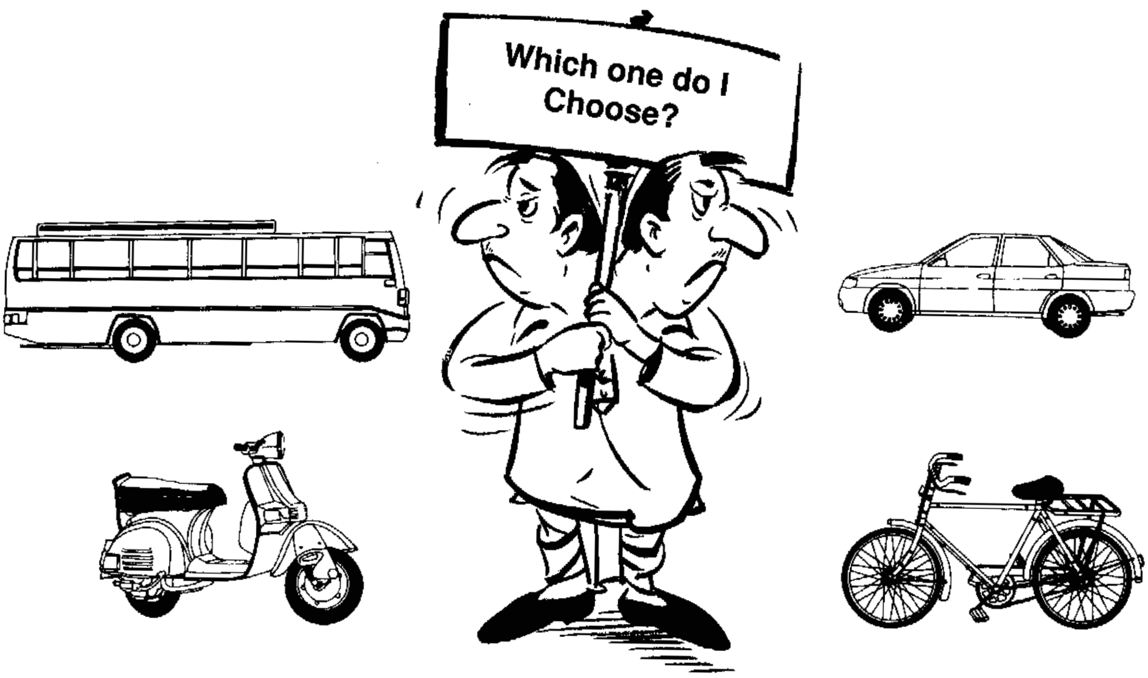
This concept can also be applied to energy cost. If a student can be taught to look at the electricity bill for example, in terms of hours of work needed to pay the bill, his/ her perspective on energy use may be altered. If the student realizes how many hours of work (as well as money) is being spent on wasteful energy habits, he/ she may become more conscious of energy conservation.

Work unit cost is described as the number of hours an individual must work to pay for a particular good or service. It is calculated by dividing the cost of an item by the hourly rate of pay that the individual earns.

Example : A person earns Rs. 10,000 a month for 8 hours of work everyday. If the person purchases a bicycle for Rs.2,500, the work unit cost of the bicycle would be

Wage per hour	=	(Monthly wage/ No of days per month)/ hours of work per day
	=	(10,000/ 30)/ 8
	=	(333.33/ 8)
	=	41.7
Hours of work needed	=	Cost of the item divided by wage per hour
	=	2500/ 41.7
	=	59.95 Hours = 59 hours and 57 minutes.

Hence the person has to work nearly 60 hours to pay for the bicycle.



WHAT AM I PAYING?

Subject Science, Social Studies, Mathematics **Group Size** Entire Class **Level** Standards 7-9 **Materials** Writing materials **Place** Inside the classroom **Duration** 30 minutes

Objectives

To help the students to

- Understand the concept of "work unit cost".
- Understand that for each of their energy wasting habits, their parents are working harder to meet the costs.

Procedure

1. Tell the students that *work unit cost* is the number of hours an individual must work to pay for a particular good or service. It is calculated by dividing the cost of an item by the hourly rate of pay of the individual. Discuss the example given in the background note.
2. Ask the students to look at the cost of every item as not just the amount marked on the price tag but also as the amount of time someone — in this case their parents — must work to pay for the goods or services needed or desired.
3. Ask them to look at their electricity bill and calculate the "work unit cost" and number of hours their parents would have worked to pay that bill.
4. Apply this concept to energy conservation. The examples below can be made specific to the energy situations most likely to be encountered by the students. For example, the following excercise could be given.

   A. *How long would your parents have to work for your brother's bad driving habits?*
   Suppose your brother is an average sort of driver and he uses about Rs. 200/- of petrol a month. Like many, he also has some bad driving habits.

   a. He drives a little fast.
   b. He lets the engine idle on many occasions when it could be turned off.
   c. He likes to be the first one away from the traffic signal when it turns green.

   Assume the above bad driving habits increase your brother's petrol consumption by Rs. 50/- a month. If your mother or father earns Rs 10,000/- a month for 8 hours of work a day in their office, how many more work hours would your mother or father have to work for the bad driving habits of your brother?

   B. *How long do your parents work to pay for wasted lighting in your home? Research has revealed that approximately 30 per cent of the average Indian household's energy budget is spent on lighting. Research has also shown that by following more efficient lighting practices, a considerable part of this energy could be saved. Turning off lights when they are not in use, using bulbs of lower wattage, and using compact fluorescent light bulbs instead of incandescent bulbs are just few ways to reduce energy spent for lighting.*
   Suppose your family's monthly electricity bill is Rs. 500/- of which Rs. 150/- is spent on lighting. If half of this expenditure, or Rs. 75/-, is wasteful, how many hours must your parent work in the office at Rs. 7,500/- a month for 8 hours of work in a day, to pay for those lights you forgot to turn off?
5. Discuss and help the students realize how many hours of work and how much of their parents' time and pay are being spent for wasteful energy habits.

WHAT AM I PAYING?

Extension/ Variation

- Discuss and ask the students to list some of their energy wasting habits.

ANSWERS

A. Increase in the petrol consumption = Rs. 50/- per month or 12 X 50 = Rs. 600/- per year.
Thus 600/ 41.7 = 14.4 hours or 14 hours and 24 minutes of your parents' working time is spent in supporting the bad driving habits.

B. Wasteful expenditure per year = Rs. 75 x 12 = 900/-.
Thus, the work hours would be 900/ 31.25 = 28.8 hours of work per year or 28 hours and 48 minutes per year.

ELECTRIFYING DAYS 13

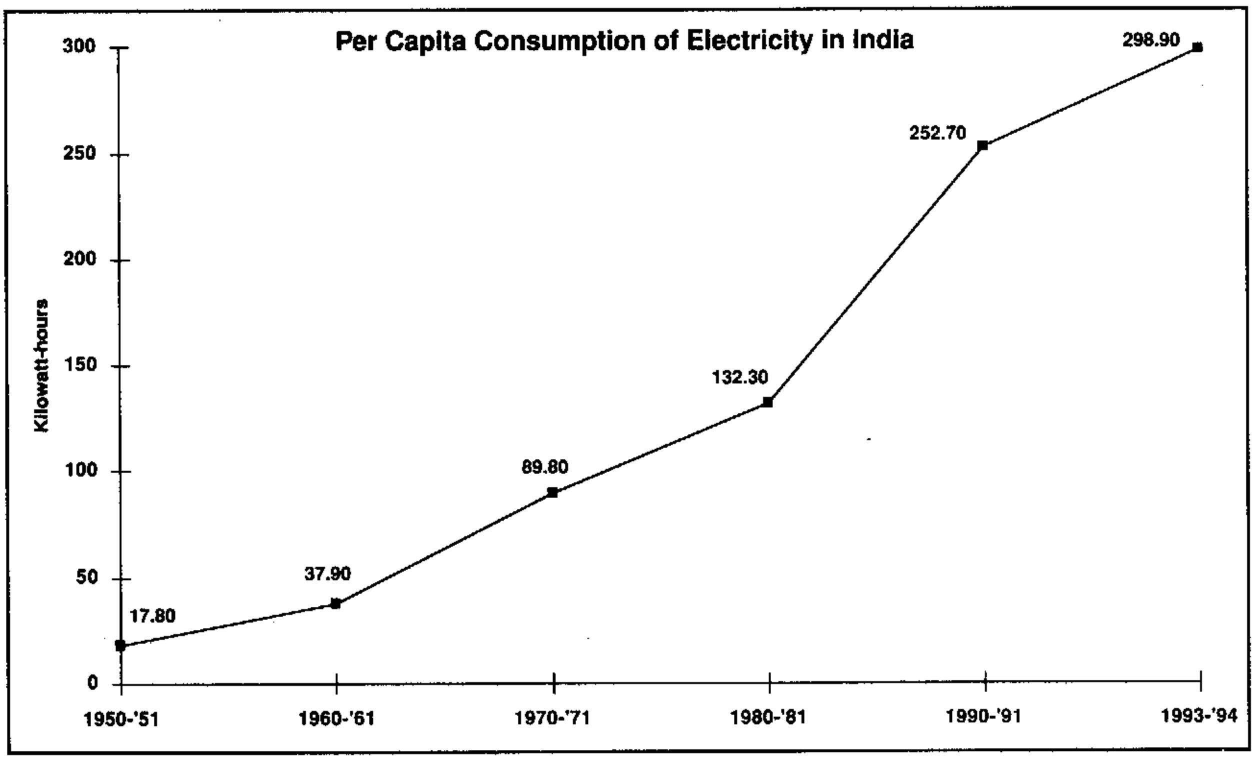
BACKGROUND

Modern living is increasingly becoming dependent on electricity, and the use of electricity is increasing rapidly. The consumption of electricity in the Indian economy as a whole rose at the rate of 2.82 per cent during the year 1996-'97, while the demand in the industrial and domestic sectors increased by 2.2 per cent and 8.8 per cent respectively. The increase is at a rate which is alarming, when compared to the generation of electricity.

The high increase of use in the domestic sector can be attributed, on the one hand to increased access to electricity and, on the other hand, to availability of electrical appliances to reduce the drudgery of housework, coupled with a higher disposable income. While increase in electricity consumption is generally taken as an indicator of development, consumption figures also include wasteful use of electricity by those who have access to it and can afford it.

Land preparation and irrigation are the two major agricultural operations which use energy. Oil (diesel) and electricity are mainly used in agriculture–diesel for land preparation and harvesting, and electricity for irrigation.

The industrial sector consumes about 50 per cent of the commercial energy produced. Seven energy-intensive industries–fertilizers, aluminium, iron and steel, textiles, cement, chemicals and paper pulp – account for nearly 80 per cent of total industrial energy consumption.



Source : The Citizens' Fifth Report - Part-II Statistical Database

ELECTRIFYING DAYS

Objectives

To help students to understand increasing dependence on electricity in our daily lives, by comparing present electricity usage and electricity usage in the past.

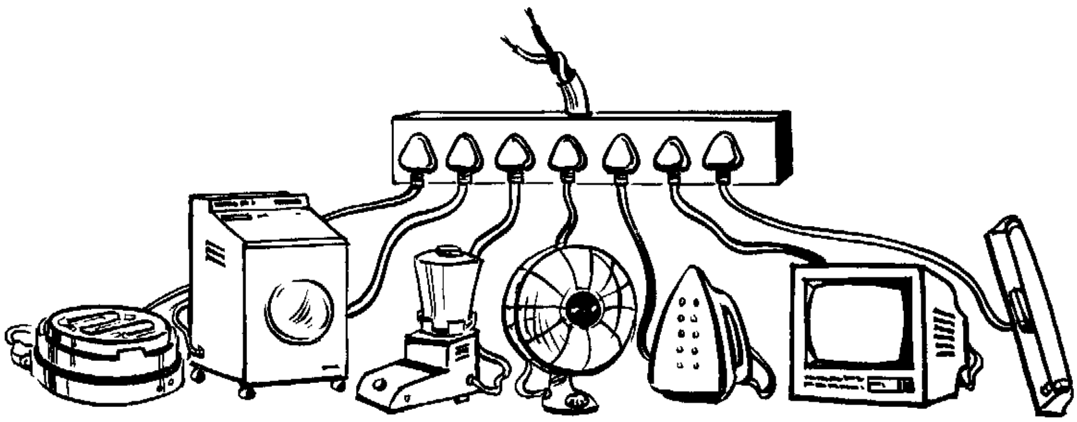
Subject
Science, Mathematics
Group Size
Entire Class
Level
Standards 6-10
Materials
Writing materials
Place
Inside the classroom and at home/ neighbourhood
Duration
30 minutes to 1 hour, plus time for take-home activities

Procedure

1. Ask the students to make a list of all appliances that they use in their daily lives now.
2. Ask them to fill in the required details in the ***Electrifying Days: Today*** sheet based on the appliances they use in their homes.
3. Ask the students to calculate the electricity consumed by multiplying the average Wattage of the appliance with the duration used per year (The average consumption for each appliance is given).
   For example, a 100 W bulb used for 5 hours in a day, would be used for (5x 365) or 1,825 hours in a year and this would consume 1,82,500 W or 182.50 kWh or Units.
4. Ask the students to observe the total electricity consumed by each one of us in our daily lives.
5. Ask the students what might happen if the energy demand increases further.
6. Let them carry the ***Electrifying Days: Yesterday*** sheet home and check with their parents, and grandparents if possible, which of these appliances they had in their homes when they were young. Ask them to mark a "Yes" or "No" in the appropriate columns.
7. In the next class, let them discuss how our domestic use of electricity has increased.

Extension/ Variation

- Have the students discuss and list the ways in which they might change their lifestyles to reduce their dependence to electricity.
- Divide the students into two groups and let them write and perform skits showing the difference between the lifestyles today and 50 years ago. Let them focus on how with change in lifestyles, energy use has increased today.



Electrifying Days: Today

Appliance	Average Wattage (W/ hr)	Duration Used per day (in hours)	Duration Used per year (in hours)	Electricity Used per year (in kWh)
Microwave Oven	1300	0.5	182.5	237.25
Mixie	300			
Toaster	1400			
Refrigerator	300			
Vacuum Cleaner	630			
Washing Machine	500			
Water Heater	2000			
Television	150			
Computer	150			
Electric Iron	1100			
Music System	100			
Hair Dryer	600			
Air Conditioner	1500			
Fan (Ceiling)	50			
Grinder	300			
Flour Mill	800			
Radio	70			
Sewing Machine	75			
Electric Shaver	15			
Electric Bulb (60W)	60			
Tube Lights	42			
Zero Watt Bulb	15			
Total				

Electrifying Days: Yesterday (Mark “Yes” or “No” in each column)

Appliances Used	Used by me now	Used by my parents when they were young	Used by my grandparents when they were young
Microwave Oven			
Mixie			
Toaster			
Refrigerator			
Vacuum Cleaner			
Washing Machine			
Water Heater			
Television			
Computer			
Electric Iron			
Music System			
Hair Dryer			
Air Conditioner			
Fan (Ceiling)			
Grinder			
Flour Mill			
Radio			
Sewing Machine			
Electric Shaver			
Electric Bulb			
Tube Lights			
Zero Watt Bulb			

ENERGY AUDIT 14

BACKGROUND

An energy audit refers to examination and verification of energy consumption in the form of electricity, gas and other forms of fuel energy, used in households, schools, industries, institutions or other public places. Energy audit undertaken periodically would reflect increase or decrease in energy used over a period of time.

A home energy audit looks at energy consumption in a home. Apart from cooking, a major use of energy in a home is for cooling or heating the space inside. Therefore, a home energy audit needs to look at the major construction, maintenance and design features of the building to gauge whether they contribute to energy efficiency.

Traditional architecture all over the world uses materials and design features that harness the available factors such as sun, wind, and water to lower or raise the temperature inside the buildings. Buildings differ from region to region depending on the local climatic conditions and on the local materials, designs and technologies. Cutting down on the use of air conditioning, installing efficient ventilation systems, orienting and planning the building in a way that utilizes sunlight and wind direction for heating or cooling, and using appropriate material for building, will make it possible to reduce energy demand by up to 70 per cent for living in a modern building .

Wet grass or mat screens across doors and windows is one of the traditional ways still used to cool indoor spaces. These work on the principle of evaporative cooling of the air passing through screens. Plantation of trees around the houses, shrubs and foliage around the buildings and creepers on the exterior walls help shield the building from the sun and keep it cool.

Apart from the architecture itself, energy saving can also be effected by habits and practices of occupants. Maintenance of the building, cleaning of lamps, tubes and fixtures, whitewashing of terraces and switching off any device when it is not in use helps towards creating an "Energy-efficient building".

ENERGY AUDIT

Subject
Science, Social Studies
Group Size
Individual
Level
Standards 8-10
Materials
Writing materials
Place
Inside the classroom, at home, and in the school
Duration
30 minutes plus time for auditing

Objectives

To help the students to

- Identify the major construction, maintenance and design features that make a building energy-efficient.
- Learn how to conduct a home electricity audit.

Procedure

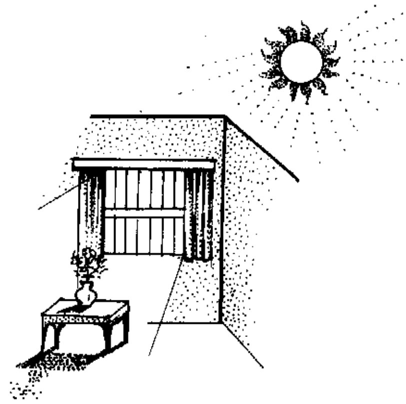
1. Read out the questions in "Survey Questionnaire" and ask the students to copy them on to their notebooks.
2. Ask the students to use the "Survey Questionnaire" and complete their observations on their home.
3. Let them also, using a format similar to one on page 47, list down the electric devices in the home and their usage. They should also study and note down the electricity bills for previous six months.
4. Ask the students to list alternatives wherever possible so that their parents (and/ or the house-owner, if staying in a rented accommodation) have choices in making conservation improvements.
5. Discuss the students' recommendations for feasibility and appropriateness (refer "Survey Recommendations Sheet" given on page 52).
6. Discuss and compare the students' observations in the class. As a class, go through survey findings to see "common" practices. Revise recommendations based on this discussion.
7. Tell the students to submit the responses of the audit report with the recommendations to their parents.
8. Ask the students to conduct a survey six months subsequent to the first audit and presentation of recommendations, to identify any improvements made in the building's energy conservation.

Extension/ Variation

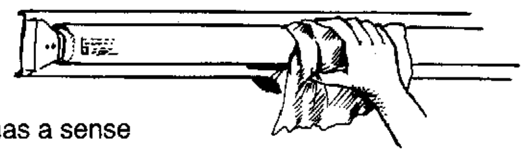
- Ask the students to describe "Energy-efficient House of the Future." How should it be designed, oriented, landscaped, and managed?
- If they were to conduct an energy audit of a factory, what factors would they look at? Ask them to develop an appropriate format.
- Let them conduct an energy audit of the school and present recommendations to the management.

ENERGY AUDIT

SURVEY QUESTIONNAIRE



1. Is the ground around the building generally covered with trees, shrubs and grass?
2. Does the building have fluorescent lighting fixtures?
3. Do you depend on ceiling fans in your house for cooling, rather than depending on high energy consuming devices like air coolers and air conditioners?
4. Are the walls and ceilings of the rooms inside the building of a light colour to reflect light?
5. Is the roof of the building in a light colour to reflect heat?
6. Have provisions been made for natural lighting wherever possible?
7. Are there few or no windows on the east and west side of the building?
8. Does the roof on the north and south side extend out from the house far enough to block the summer sun from walls and windows?
9. Are the water taps free from drips?
10. Are all appliances turned off when the work is completed?
11. Is the person who cleans your home instructed to turn off all but necessary lights and fans while he/she works?
12. Does any one in your home perform a "Night close-out Checklist"?
13. Is routine cleaning of lamps, tubes and fixtures part of your home energy management programme?



14. Are all people living in the building concerned about energy conservation measures, so that each individual has a sense of responsibility?
15. Is monthly energy consumption and cost data available, so that data can be evaluated and compared against similar months in previous years and against the energy budget?

ENERGY AUDIT

SURVEY RECOMMENDATIONS

1. Green trees, shrubs and grass absorb much of the sun's heat around a building. They also make a building more attractive and cost very little. The preferred answer is "Yes".
2. Fluorescent light bulbs use much less electricity than incandescent bulbs. They also last a great deal longer. The answer should be "Yes".
3. The preferred answer is "Yes". Ceiling fans are a good addition to natural ventilation, to increase air circulation and keep the occupants of the building cool and comfortable. Air coolers and air conditioners used for this purpose use a lot of energy and are expensive to operate.
4. The preferred answer is "Yes". Lighter colours reflect light. This decreases the need for energy for lighting by almost 15 to 20 per cent.
5. A lighter coloured roof decreases the absorption of heat by almost 10 per cent, thus reducing the need for energy consuming air-cooling appliances. Simple whitewashing of the roof has been found to reduce the temperature by 3° to 5° Celsius. The preferred answer is "Yes".
6. The preferred answer is "Yes". In a tropical country like ours, where sunlight is plentiful, proper orientation of windows and doors would considerably reduce the need for use of artificial lights inside the rooms during the day.
7. Fewer windows on the east and west side of the building means reduced entry of hot afternoon sun rays into the building and reduced heating of the room. The preferred answer is "Yes".
8. In India, the position of the sun during the warmer days of the year is southwest for places above the Tropic of Cancer (above Gujarat, Madhya Pradesh, and Orissa), and northwest in direction for places below the Tropic of Cancer. An extended roof on the north and south sides would help prevent the afternoon sun from penetrating inside and raising the room temperature. The preferred answer is "Yes".
9. The preferred answer is "Yes". Even a slow dripping tap may waste up to 75 litres of water everyday, i.e., 27,375 litres of water every year. To pump this water, your motor would have consumed approximately 50 units of electricity.
10. The preferred answer is "Yes". Leaving any unused appliance "on" means wasting useful electricity. No unused appliance should remain "on" after the work is completed.
11. Although this seems insignificant, it is very important. A great deal of energy can be saved by just not simultaneously lighting up two to three rooms in the house during clean up. Advice them to light only the room they are actively cleaning. The answer is "Yes".
12. A "night close-out checklist" usually ensures that all energy conservation measures are complied with. The answer is "Yes". Ensure the list covers turning off all unnecessary equipments, fans, lights, closing or opening doors and windows according to season.
13. The dust that settles on the lamps reduces the intensity of light (lumens), creating demand for light bulbs of higher Wattage. The cleaning of lamps and reflectors on the lamps is very important and should be done regularly. The answer is "Yes".
14. Acceptance of responsibility for energy conservation by all is very desirable and can come about with much discussion. If all the residents of a building decide to lower energy bills, there is no doubt that the bills will come down. This answer is "Yes".

15. This question is probably the most important one in the questionnaire. If an owner decides to lower the energy bills of the building, there is no doubt that the bills will come down. It is easier to conserve energy when one knows how much is used. Comparing costs and discussing energy conservation makes us all aware of the need to save energy. The answer should be "Yes".

FUEL SAVING DRIVE

15

BACKGROUND

The total number of motor vehicles on Indian roads increased from 3,06,000 in 1950-'51 to 2,14,28,000 in 1991-'92, a 70 times increase. It has further increased very rapidly to a figure of 3,72,31,000 in 1997, an increase of almost two times within a span of 5 years. This has led to an enormous increase in petrol and diesel consumption.

Registered Motor Vehicles in India (in thousands)

CATEGORY	1971	1980	1990	1995	1997
Two-wheelers	576	2117	12611	20831	25693
Cars, jeeps and taxis	682	1059	2694	3841	4662
Buses	94	140	298	423	488
Goods vehicles	343	473	1238	1794	2260
Others	170	732	2311	3406	4128
All vehicles	1865	4521	19152	30295	37231

Source: TEDDY 1999-2000

While vehicles are gradually becoming more energy-efficient, careless practices and bad driving habits can decrease the efficiency of the vehicles. Some of the measures towards increasing the efficiency of vehicles are not difficult to implement. For instance, we often leave unwanted things inside the vehicle. By removing such unwanted luggage from the storage area of the vehicle, we can reduce the vehicle's weight — at times by 5 or more kilograms — and help increase its efficiency. Similarly, we often change a vehicle's contours by adding features. The vehicles are designed with streamlined contours for achieving maximum efficiency. Removing features like luggage racks which break the contours and restoring the vehicle's aerodynamics, and unloading unused luggage, could help improve the fuel efficiency by 0.1 to 0.5 km/ l.

Avoiding unnecessary trips during peak traffic hours and driving at the optimum speed recommended for the vehicle can help to increase a vehicle's fuel efficiency. Driving above the optimum speed limit not only leads to the vehicle using more fuel in itself, but since the brakes of the vehicle would have to be applied more frequently, it leads to the burning of more energy. Rapid acceleration reduces the vehicle's efficiency. Warming up the engine before driving and gunning the engine before shutting it off consumes unnecessary fuel, lowering the efficiency.

Maintenance of the vehicle is also very important, because poor vehicle maintenance unnecessarily increases fuel consumption. Engine oil needs to be regularly changed, as old thick oil loses important friction-reducing and fuel-saving additives causing the engine to waste energy. Proper tyre balance and wheel alignment are important for optimizing fuel economy. Under-inflation promotes rapid tyre wear and could be unsafe. Tyres as little as two kilograms under-inflated can reduce fuel economy by 2 to 10 per cent.

ENERGY AUDIT

SURVEY RECOMMENDATIONS

1. Green trees, shrubs and grass absorb much of the sun's heat around a building. They also make a building more attractive and cost very little. The preferred answer is "Yes".
2. Fluorescent light bulbs use much less electricity than incandescent bulbs. They also last a great deal longer. The answer should be "Yes".
3. The preferred answer is "Yes". Ceiling fans are a good addition to natural ventilation, to increase air circulation and keep the occupants of the building cool and comfortable. Air coolers and air conditioners used for this purpose use a lot of energy and are expensive to operate.
4. The preferred answer is "Yes". Lighter colours reflect light. This decreases the need for energy for lighting by almost 15 to 20 per cent.
5. A lighter coloured roof decreases the absorption of heat by almost 10 per cent, thus reducing the need for energy consuming air-cooling appliances. Simple whitewashing of the roof has been found to reduce the temperature by 3° to 5° Celsius. The preferred answer is "Yes".
6. The preferred answer is "Yes". In a tropical country like ours, where sunlight is plentiful, proper orientation of windows and doors would considerably reduce the need for use of artificial lights inside the rooms during the day.
7. Fewer windows on the east and west side of the building means reduced entry of hot afternoon sun rays into the building and reduced heating of the room. The preferred answer is "Yes".
8. In India, the position of the sun during the warmer days of the year is southwest for places above the Tropic of Cancer (above Gujarat, Madhya Pradesh, and Orissa), and northwest in direction for places below the Tropic of Cancer. An extended roof on the north and south sides would help prevent the afternoon sun from penetrating inside and raising the room temperature. The preferred answer is "Yes".
9. The preferred answer is "Yes". Even a slow dripping tap may waste up to 75 litres of water everyday, i.e., 27,375 litres of water every year. To pump this water, your motor would have consumed approximately 50 units of electricity.
10. The preferred answer is "Yes". Leaving any unused appliance "on" means wasting useful electricity. No unused appliance should remain "on" after the work is completed.
11. Although this seems insignificant, it is very important. A great deal of energy can be saved by just not simultaneously lighting up two to three rooms in the house during clean up. Advice them to light only the room they are actively cleaning. The answer is "Yes".
12. A "night close-out checklist" usually ensures that all energy conservation measures are complied with. The answer is "Yes". Ensure the list covers turning off all unnecessary equipments, fans, lights, closing or opening doors and windows according to season.
13. The dust that settles on the lamps reduces the intensity of light (lumens), creating demand for light bulbs of higher Wattage. The cleaning of lamps and reflectors on the lamps is very important and should be done regularly. The answer is "Yes".
14. Acceptance of responsibility for energy conservation by all is very desirable and can come about with much discussion. If all the residents of a building decide to lower energy bills, there is no doubt that the bills will come down. This answer is "Yes".

15. This question is probably the most important one in the questionnaire. If an owner decides to lower the energy bills of the building, there is no doubt that the bills will come down. It is easier to conserve energy when one knows how much is used. Comparing costs and discussing energy conservation makes us all aware of the need to save energy. The answer should be "Yes".

FUEL SAVING DRIVE

BACKGROUND

The total number of motor vehicles on Indian roads increased from 3,06,000 in 1950-'51 to 2,14,28,000 in 1991-'92, a 70 times increase. It has further increased very rapidly to a figure of 3,72,31,000 in 1997, an increase of almost two times within a span of 5 years. This has led to an enormous increase in petrol and diesel consumption.

Registered Motor Vehicles in India (in thousands)

CATEGORY	1971	1980	1990	1995	1997
Two-wheelers	576	2117	12611	20831	25693
Cars, jeeps and taxis	682	1059	2694	3841	4662
Buses	94	140	298	423	488
Goods vehicles	343	473	1238	1794	2260
Others	170	732	2311	3406	4128
All vehicles	1865	4521	19152	30295	37231

Source: TEDDY 1999-2000

While vehicles are gradually becoming more energy-efficient, careless practices and bad driving habits can decrease the efficiency of the vehicles. Some of the measures towards increasing the efficiency of vehicles are not difficult to implement. For instance, we often leave unwanted things inside the vehicle. By removing such unwanted luggage from the storage area of the vehicle, we can reduce the vehicle's weight — at times by 5 or more kilograms — and help increase its efficiency. Similarly, we often change a vehicle's contours by adding features. The vehicles are designed with streamlined contours for achieving maximum efficiency. Removing features like luggage racks which break the contours and restoring the vehicle's aerodynamics, and unloading unused luggage, could help improve the fuel efficiency by 0.1 to 0.5 km/ l.

Avoiding unnecessary trips during peak traffic hours and driving at the optimum speed recommended for the vehicle can help to increase a vehicle's fuel efficiency. Driving above the optimum speed limit not only leads to the vehicle using more fuel in itself, but since the brakes of the vehicle would have to be applied more frequently, it leads to the burning of more energy. Rapid acceleration reduces the vehicle's efficiency. Warming up the engine before driving and gunning the engine before shutting it off consumes unnecessary fuel, lowering the efficiency.

Maintenance of the vehicle is also very important, because poor vehicle maintenance unnecessarily increases fuel consumption. Engine oil needs to be regularly changed, as old thick oil loses important friction-reducing and fuel-saving additives causing the engine to waste energy. Proper tyre balance and wheel alignment are important for optimizing fuel economy. Under-inflation promotes rapid tyre wear and could be unsafe. Tyres as little as two kilograms under-inflated can reduce fuel economy by 2 to 10 per cent.

FUEL SAVING DRIVE

Objectives

To help the students to
- Understand how small, low-cost vehicle maintenance practices can increase a vehicle's fuel economy.
- Identify driving habits which increase fuel consumption.

Subject
Science, Social Studies
Group Size
Entire class
Level
Standards 8-10
Materials
Writing materials
Place
Inside the classroom, at home/ neighbourhood
Duration
30 minutes to 1 hour, plus time for take-home activities

Procedure

1. Discuss with the students some bad driving and maintenance habits and how these could be rectified to help us save many litres of fuel, and reduce emissions and pollution of the environment.
2. Read out the "Auto Quiz Questions". Discuss these and the preferred answers in the "Auto Quiz Recommendations". Ask the students to copy both these in their notebooks (if possible photocopies could be distributed).
3. Tell the students that the "Auto Quiz" is a "quiz" for any vehicle owner or driver, to draw their attention to proper ways to use and maintain their vehicles.
4. Tell each student that they must give the quiz to at least 3 persons.
5. Ask the students to inform the driver that they are going to conduct a quiz and then to pose the "Auto Quiz Questions" to which the drivers must answer with a "Yes" or "No".
6. Ask the students to inform the drivers that the quiz scores would help them understand how many of their practices are energy wasting.
7. After asking the quiz questions, tell the students to give the ratings and recommendations for each energy wasting habit.

Extension/ Variation

- Ask the students to ponder this: An unwanted tool box weighing 25 kg could lower a car's fuel efficiency up to 0.72 km/ l. If someone currently gets 15 km/ l and they drive 15,000 kilometers a year, they could save 46 litres of fuel! At Rs. 40/- per litre that would save Rs. 1,840/- per year, or it would be like driving almost 723 kilometers "free!".

FUEL SAVING DRIVE

AUTO QUIZ QUESTIONS

a. Is there any excess weight in the vehicle (for example, decorative items, unwanted luggage, etc.)?

b. Is there any un-needed luggage carrier or other items, like decorative items, etc., that just hang loose or break the contour and the streamlining of the body, and thus the aerodynamism of the vehicle?

c. Are you usually the first to get away from the signal light?

d. Do you anticipate traffic slow-downs, stop signs, and signal lights and slow down gradually?

e. When possible, do you plan your trips at times other than peak traffic hours (9-11 a.m., or 5-8 p.m.)?

f. Do you start the engine and proceed immediately?

g. Do you "gun" the accelerator prior to turning off the key?

h. Do you maintain a steady driving speed?

i. Do you use the features in the vehicle to your advantage whenever needed? For example, when attempting a right turn, do you use right turn indicator signal lights to clear your way and gradually slow down to turn, rather than braking suddenly to let the speeding vehicle have its way?

j. Do you keep the engine running idle for over 60 seconds when waiting in the traffic signals or when waiting for a passing train at the level crossing?

k. Have you checked or changed your air filter in the last six months or after driving 6,000 kilometers?

l. Have you changed your engine oil in the last six months or after driving 5,000 kilometers?

m. Do you check your engine oil at least once every five times you stop for refueling?

n. On a smooth road, does your vehicle vibrate or bounce, (indicating low tyre inflation)?

o. Do you use the manufacturer's recommended viscosity oil?

p. Have you had a service and tune-up in less than one year or after driving 10,000 kilometers?

q. Do you check your tyre pressure every time you re-fill fuel?

r. Have you got your vehicle PUC (Pollution Under Control) certified?

Get Set Go!

For Amdavadis given to blaring horns and allowing vehicles to emit noxious fumes even when the red signal is on so that they can drive off as soon as the red turns to green, the new addition in the form of a white light with `tayar raho' in red should be a welcome sign. The signal has been installed at the Nehru Bridge crossing on an experimental basis.

Another experiment is the timer installed at the Usmanpura crossing, near Gandhi Bridge, which gives commuters an idea of the waiting period.

"It is good step as it ensures that we are ready as soon as the light turns green", said autorickshaw driver Ramanbhai Patel commenting on the `tayar raho' signal. Another rickshaw driver beamed, "With the new indicator we can turn off the rickshaw and wait without anxiety for the light to turn green". Radha Mehta, who was driving a two-wheeler heaved a sigh of relief on seeing the timer show 42 seconds to go, said, "This is a positive step towards regularising traffic in the city".

Elaborating on the experiment, Deputy Commissioner of Police (Traffic), Samiullah Ansari said, "We will implement the new addition after assessing response from people". He added that timers would be installed at all traffic junctions within a month if it proved a success. Ansari said the idea behind the blinker and timer was to make things easier for the waiting commuter as with the vehicles turned off, it would also help conserve fuel and check pollution to an extent. When the amber light flashes, all commuters try to cross the junction, but if the timer shows that there are just two seconds left for the light to turn red, the driver would rather stop.

Source : Indian Express, Ahmedabad Newline, February 29, 2000.

FUEL SAVING DRIVE

RATING AND RECOMMENDATIONS

The person you interviewed should have answered the questions as follows:

No : a, b, c, g, j, and n.

Yes : d, e, f, h, i, k, l, m, o, p, q and r.

For each correct answer, give 5 points. If they score:

75 or more	:	Congratulate the person as he/ she is an energy saving driver!
60 to 75	:	Inform the person, that he/ she has passed the test, but there is still room for improvement!
50 to 60	:	Advice the person that he/ she can save some money and energy too! Point out where he/ she often makes mistakes.
50 and less	:	The person needs to seriously look at his/ her driving and energy attitudes. He/ she needs to seriously evaluate and do something about wasteful driving habits.

AUTO QUIZ RECOMMENDATIONS

a. The preferred answer is "No". Removing the unwanted luggage will reduce the vehicle's weight by 5 or more kilograms and may considerably improve the mileage.

b. The preferred answer is "No". Removing the unused luggage rack and other contour-breaking features could restore the vehicle's aerodynamics and improve the vehicle's fuel efficiency.

c. The preferred answer is "No". Rapid acceleration may reduce the mileage considerably.

d. The preferred answer is "Yes". Rapid acceleration and delay in applying the brake for the upcoming stop sign or red signal light may reduce the mileage considerably.

e. The preferred answer is "Yes". By avoiding unnecessary trips during peak traffic hours and driving above or below the optimum speed limit of the vehicle, many drivers could increase their vehicle's fuel efficiency.

f. The preferred answer is "Yes". Warming up the engine before shutting off consumes unnecessary fuel, lowering the km/ l. The manufacturers of fuel efficient vehicles no longer recommend the 10-15 second engine warm-up. They do recommend no hard acceleration, heavy pulling, or steep hill climbing for the first kilometre or so.

g. The preferred answer is "No". Gunning the engine before shutting off consumes unnecessary fuel, lowering the efficiency.

h. The preferred answer is "Yes". Driving above the optimum speed limit not only uses more fuel, but the driver is more likely to brake more frequently. The more rapid the stop, the more quickly energy is being wasted. Gradual acceleration, driving at a moderate speed, and smooth stopping can help a vehicle deliver its optimum fuel economy.

i. The preferred answer is "Yes". The features in the vehicle could help the driver get his/ her way cleared and help him/ her to brake less frequently. Driving at a moderate speed and smooth stopping help a vehicle deliver its optimum fuel economy.

FUEL SAVING DRIVE

j. The preferred answer is "No". When a vehicle is not moving and the engine is running, the vehicle gets ZERO km/ l. Those "ZERO's" negatively impact efficiency.

k. The preferred answer is "Yes". Dirty air cleaners restrict engine's air flow intake and result in an excessively fuel rich mixture.

l. The preferred answer is "Yes". Old spent oil loses important engine-protecting, friction-reducing, fuel-saving additives and causes the engine to waste energy.

m. The preferred answer is "Yes". Old thick oil causes the engine to waste energy.

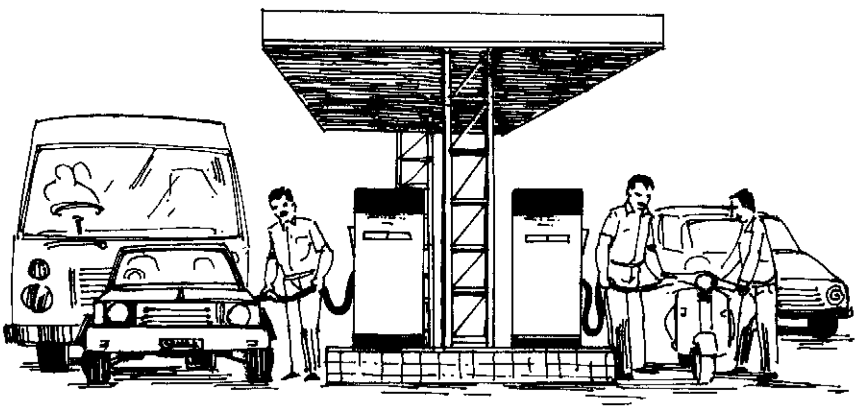
n. The preferred answer is "No". Tyre balance and wheel alignment are important for optimising fuel economy.

o. The preferred answer is "Yes". Owner's manuals list appropriate viscosity (weight), and grades of oil that provide protection against engine wear and deterioration. Typically, manufacturers provide a chart illustrating the recommended viscosity as a function of vehicle load and ambient temperature. Both conditions — too high a viscosity or too low a viscosity —will result in excessive engine wear. If the viscosity is too high for the ambient temperature, the oil pump will have to work more to deliver the oil and result in lower mileage. Conversely, if the oil viscosity is too low, then the engine will have an excessive amount of internal friction. Lower mileage will result.

p. The preferred answer is "Yes". Ignition tune-ups include checking, adjusting and replacing critical components such as the spark plugs, spark plug wires, distributor cap and rotor, vacuum lines, ignition timing and critical emissions control devices. These components must deliver the ignition spark at the precise instant to burn the fuel effectively and efficiently. Ignition timing that is off by as little as 3 or 4 milliseconds (that's 3 or 4 millionths of a second!) can significantly reduce fuel economy. Each component must operate optimally for a vehicle to retain its designed fuel economy.

q. The preferred answer is "Yes". Low tyre inflation is the most cited tyre-related-fuel eater. Tyres as little as two kilograms under-inflated can reduce fuel economy by 2, 5, or even 10 per cent. Under-inflation promotes rapid tyre wear and could be unsafe.

r. The preferred answer is "Yes". PUC certificates indirectly serve as a guide to the performance of the vehicle and the maintenance needed. If below standard, the vehicles need to be serviced and brought up to proper operating level.



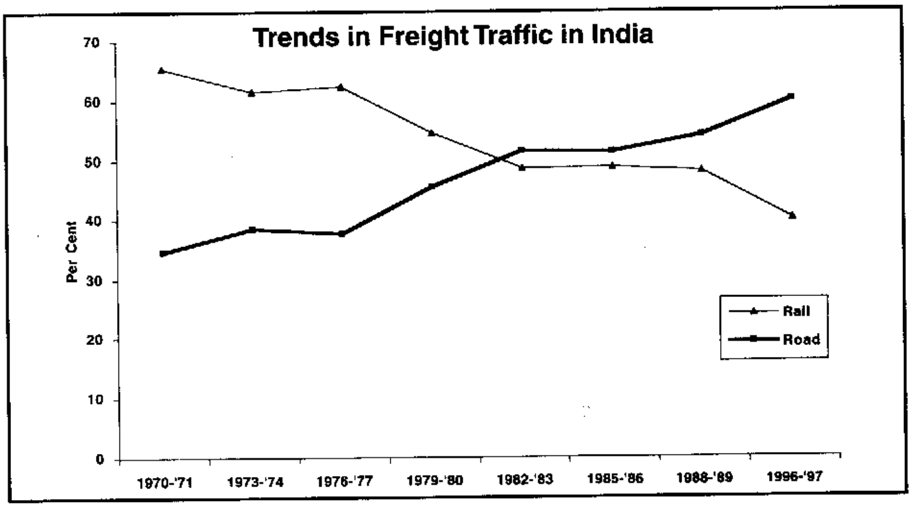
16 WISE TRAVELLER

BACKGROUND

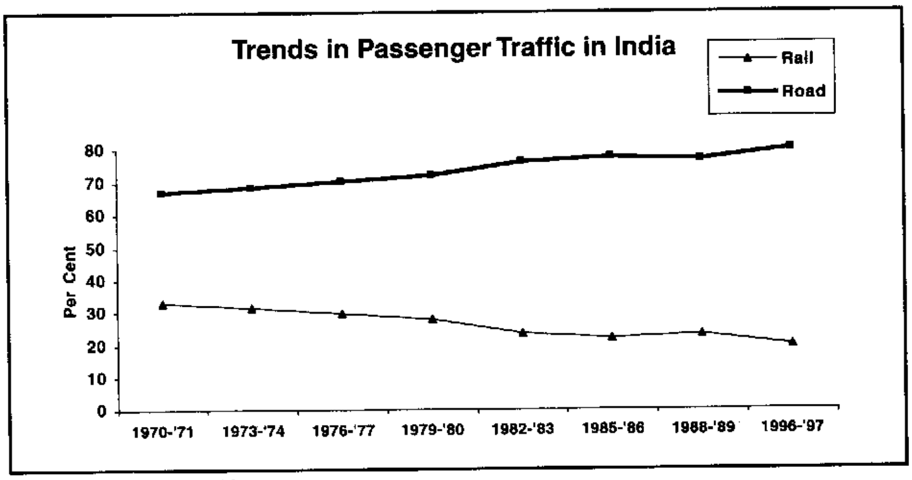
Transport plays an important role in the overall development of the national economy. The transport sector in India is a major energy-consuming sector, particularly of oil. Almost half of the total petroleum products of the country are consumed by the transport sector in the form of high-speed diesel and petrol.

Commercial energy consumption in the transport sector has increased at the rate of 3.1 per cent a year between 1970-'71 and 1980-'81. It grew at a much faster rate of 4.9 per cent a year between 1980-'81 and 1990-'91, and at 5.6 per cent a year during 1990-'91 to 1997-'98. The higher rates of growth of energy consumption can be attributed to the shift that has occurred from a rail dominant economy of the 1950s, to a road dominant economy in the 1980s. Also, there has been a sharp increase in the use of personalized modes of transport, partly due to inadequacy of public transport systems.

With the increase in diesel and petrol consumption and the limited resources available to us, there is a need to look at alternative modes of transportation. Small changes in our habits like cycling or walking short distances instead of taking a vehicle, can help to save a lot of fuel.



Source : TEDDY 1999-2000



Source : TEDDY 1999-2000

WISE TRAVELLER

Objectives

To help the students to

- Become aware of various types of transportation and how much fuel is consumed by each.
- Calculate and compare the energy efficiency of a variety of automobile models in the market.

Subject
Science, Mathematics, Social Studies

Group Size
Entire class

Level
Standards 7-9

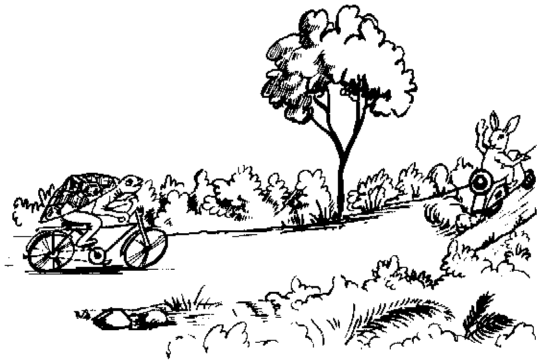
Materials
Writing materials

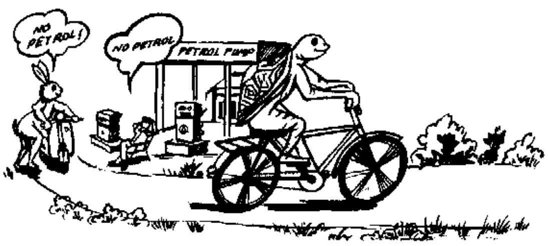
Place
Inside the classroom, at home/ in the neighbourhood

Duration
30 minutes to 1 hour, plus variable time for outdoor activities

Procedure

1. Have the students ask their local bus station or any bus driver the following questions:
   a. What is the fuel used?
   b. What is the cost of the fuel per litre?
   c. What is the average distance (in kilometers) the vehicle travels per litre of fuel?
   d. How many people can ride on the vehicle?
   e. How many people usually (at least on 50 per cent of the occasions) ride on their vehicle?
2. Ask the students to interview a couple of drivers of cars, autorickshaws, motorcycles, scooters and other vehicles to get the above details for their vehicles. Record all the data in the "Transportation Chart" (see page 60).
3. Ask the students to calculate the fuel used per person if he/ she goes the same distance by bus, car, motorcycle, bicycle, and other forms of transportation.





WISE TRAVELLER

Transportation Chart

Vehicle	Fuel Used	Average No. of Passengers	Fuel Efficiency km/ l	Litres per Kilometre per Person	Cost per Person per Kilometre
Moped					
Scooter					
Motor Cycle					
Autorickshaw					
Car					
Jeep					
Van					
Mini Bus					
Bus					

Extension/ Variation

- Ask the students the following questions:
  a. Which form of transportation do you choose most often, and why?
  b. What other factors are considered in choosing a mode of transportation?
  c. Which form of transportation is most energy-efficient?
- Ask the students to collect brochures of different models of any one type of vehicle (say a car/ scooter/ motorcycle/ moped).
  a. Let them mark the salient features of each model that are used for promoting its sales.
  b. Let them find out efficiency in km per litre of fuel.
- Ask the students to also compare walking and bicycling with these options.
- Ask the student to put together a "Transportation Guide of the 2000's" that advertises a current model of the type of automobile that is most fuel efficient and energy conserving. Throughout the year, more drawings, pictures and information about transportation can be added.
- Ask them, if given an option (assuming that they know to ride/ drive all the vehicles), which model and brand would each student select for his/ her personal use and why? What criteria did they consider in making their selection?
- Ask them to plan and organize a 'Wise Traveller Campaign' for the school, aimed at: cutting down use of personal vehicles, encouraging use of bicycles, public transport and pooling.

THE WISE SHOPPER

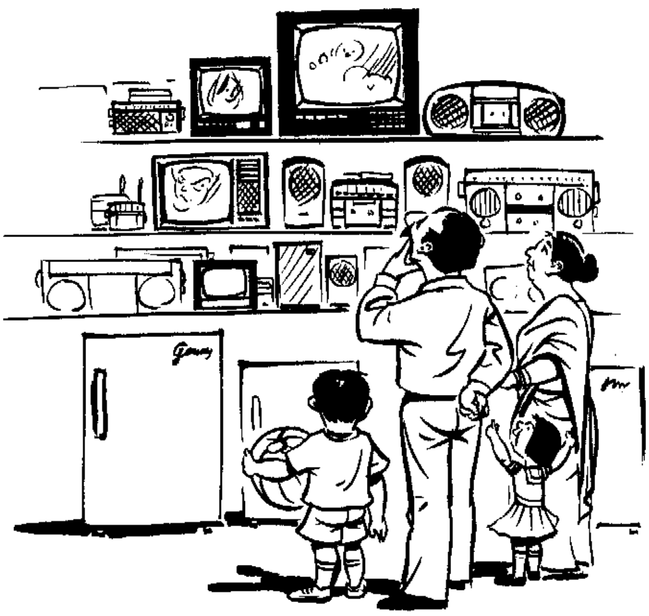
BACKGROUND

With our increasing use of appliances such as televisions, refrigerators, washing machines, ceiling fans, electrical irons and geysers, electricity consumption is increasing rapidly. It becomes important for a consumer to look at the energy efficiency of the appliance in order to conserve energy. Along with comparing price and product features, it is also necessary to look for wattage ratings which help to compare the energy efficiency of different models.

Rising per capita income associated with urbanization increases demands for both end-use energy particularly of fuels such as electricity and LPG, as well as for energy intensive products and services.

Home Appliances

Appliance	Type	Wattage Rating	Running Time for Consumption of 1 Unit
Bulb	Incandescent	60 W	16 Hours 40 Minutes
	CFL	15 W	67 Hours
Airconditoner	1 - 1.5 tonnes	1500 W	40 Minutes
Refrigerator	Ordinary 165 litres	225 W	4 Hours 45 Minutes
	Frost free 165 litres	350 W	2 Hours 52 Minutes
Water Heater	Instant Geyser	3000 W	20 Minutes
	Storage Type	2000 W	30 Minutes
	Immersion Rod	1000 W	1 Hour
Washing Machine	Semi-automatic	210 W	4 Hours 45 Minutes
	Automatic	230 W	4 Hours 20 Minutes



THE WISE SHOPPER

Subject
Science, Mathematics
Group Size
Entire class
Level
Standards 7-9
Materials
Writing materials
Place
Inside the classroom, at home
Duration
30 minutes to 1 hour

Objectives

To help the students to
- Make appliance choices with energy efficiency as an important criterion.
- Use Wattage details of appliances and cost information to determine which appliance is the best energy buy.

Procedure

1. Tell the students that the total cost of an appliance (the initial cost and the operating cost) can be calculated using the Wattage consumption of any appliance, and that this understanding would help us have a better idea as to which brand or model is a better buy in the long run.
2. Give the students the following example for calculation of the total cost.
   Calculate and find which is a better buy between the two refrigerators described: a model "A" that costs Rs. 10,000/- and consumes 300 W for every hour used, or a model "B" that costs Rs. 15,000/- and consumes 200 W for every hour used. A refrigerator will last approximately for 15 years. Assume the cost of electricity to be Rs. 3.50 per kWh (one unit) and that the refrigerator is operated for 24 hours a day.

   ### Answer

   Step 1 Calculate the energy consumed in a year by multiplying the Wattage of the appliance with the number of hours used per day and by number of days in a year.
   Model "A" would consume 300 X 24 X 365 = 26,28,000 W or 2,628 kWh or 2,628 Units.
   Model "B" would consume 200 X 24 X 365 = 17,52,000 W or 1,752 kWh or 1,752 Units.

   Step 2 Calculate the annual operating cost by multiplying the wattage consumed in a year with the cost per unit.
   The annual operating cost of Model "A" 2,628 X 3.50 = Rs. 9,198/-.
   The annual operating cost of Model "B" 1,752 X 3.50 = Rs. 6,132/-.

   Step 3 Compare the total cost (the initial cost plus the operating cost, over the appliance's life time) of the two appliances.
   The total cost for Model "A" is
   10,000 + (9,198 X 15) = Rs. 1,47,970/-.
   The total cost for Model "B" is
   5,000 + (6,132 X 15) = Rs. 1,06,980/-.
   The difference 1,47,970-1,06,980 = Rs. 40,990/-.

   This answer tells us that since a refrigerator will probably last 15 years, the model "B" whose initial cost was more by Rs. 5,000/- would in fact work out cheaper by Rs 40,990/- in the total cost. Thus, Model"B" is the better buy of the two.
3. Give the following exercise and ask the students to calculate for practice.
   a. Which is the better buy — a geyser "A" that costs Rs. 3,500/- and consumes 2,000 W to operate, or a geyser "B" that costs Rs. 4,000/- and consumes 1,500 W to operate? A geyser will last 20 years. Let us assume that the geyser is used for one hour every day and the cost of electricity is Rs. 3.50 per kWh.

b. Which is the better buy — a water pump that costs Rs. 3,000/- and consumes 900 W to operate, or a water pump that costs Rs. 4,500/- and consumes 800 W to operate? A water pump will last 15 years. Let us assume that the water pump is used for one hour everyday and the cost of electricity is Rs. 3.50 per kWh.

4. As a home task, ask the students to collect Wattage details of various appliances they have at their home and list them in the **Wise Shopper** table given below and do the necessary calculations. (Inform the students that Wattage details are given in the instruction manual of all appliances and also often on the appliance, near the power chord of the appliance or at the bottom).
5. In the next class, put down on the board the name of one of the appliances, for example, refrigerator. Then ask the students to call out the names of different brands and the total cost for 10 years. After all the data is on the board, discuss which is the best energy buy (make sure the data is comparable – e.g., with regard to size of refrigerator). Proceed to do the same for the other common appliances.

Extension/ Variation

- Ask your students the following questions:
  a. Should a person be concerned about the Wattage consumption of an appliance? Do you ask for this detail while purchasing any product?
  b. What factors, besides energy efficiency, affect purchase decisions?
  c. Tell them that these details need to be taken into consideration not only at home, but also in offices, factories, etc. Let them discuss with their parents whether they look into energy efficiency in purchases of fittings, machines, etc. in their work places.

Wise Shopper

Appliance	Model	Brand	Initial Cost	Wattage	Operating Cost for 10 years	Total Cost

Answers

3. a. Total cost for A is Rs. 41,825/- and B's total cost is Rs. 32,743.75/-. "B" is the better buy between the two.

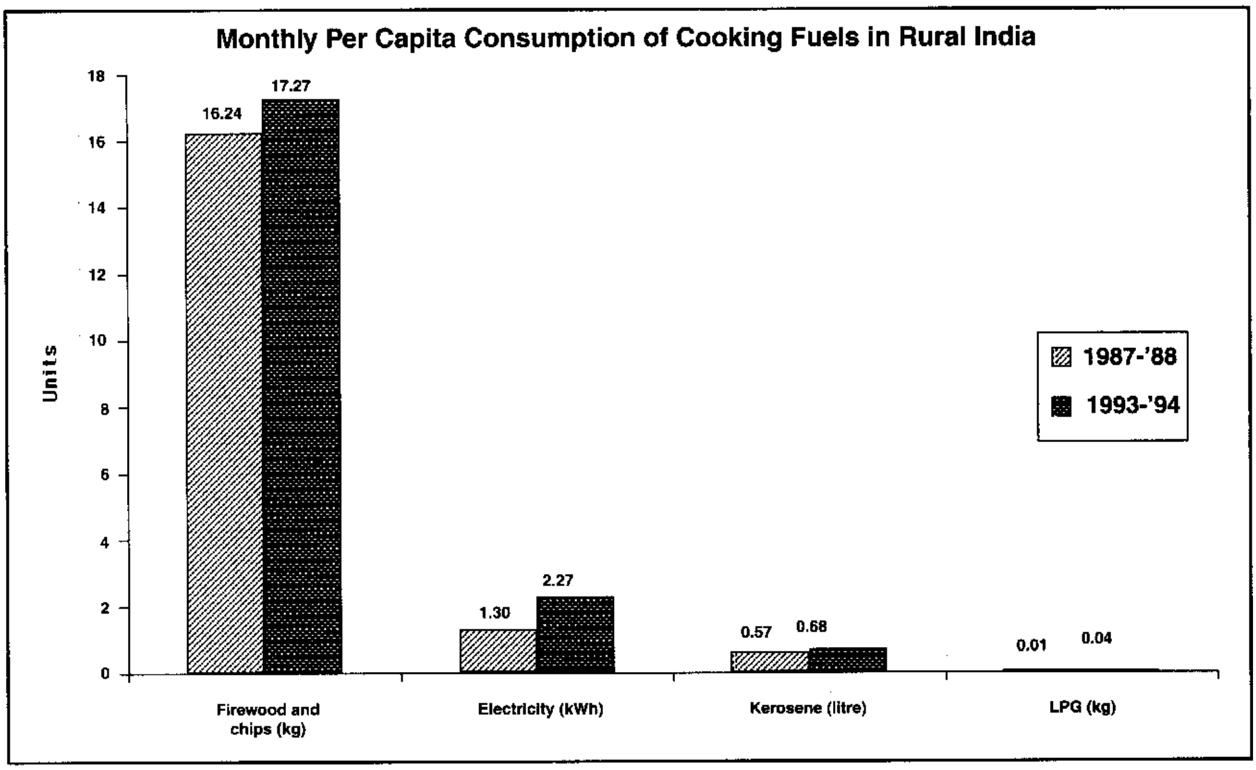
3. b. Total cost for A is Rs. 20,246.25/- and "B's" Total cost is Rs. 19,830/-. "B" is the better buy between the two.

18 THE RATNAGIRI DILEMMA

BACKGROUND

The household sector accounts for 75 per cent of the total energy consumption in rural areas. Within the household sector, it is estimated that cooking accounts for over 90 per cent of the energy consumed. In most parts of the country, rural households use traditional mud stoves, which are energy inefficient.

It is estimated that every year, about 200 million tonnes of fuelwood, 100 million tonnes of dungcakes, and 100 million tonnes of non-fodder crop residues are consumed as fuels in rural areas. Firewood is the most prevalent primary source of energy in rural households (78 per cent). During 1987-'88 to 1993-'94, the monthly per capita consumption of firewood increased from 16 kg to 17 kg. It is in this scenario that energy conservation in cooking becomes essential. One way to achieve this is by adopting energy efficient alternative technologies.



Source : TEDDY 1999-2000

There is need to shift to alternative energy sources as a step towards conserving fuel resources, conserving forests and the environment. Biogas is one possible alternative fuel. It is a clean and inexpensive energy source that helps produce enriched manure and improves sanitation. One disadvantage of the biogas plant is that due to unavailability of trained masons in the village, any breakage or leakage would mean depending on some external source to rectify it and would involve some cost.

An improved chulha is an example of an improved, fuel-efficient technology. The National Programme on Improved chulhas was launched in 1984-'85 with the objectives of fuel conservation, reduction of smoke, conservation of forests and environment, providing employment and elevating the status of women and children in the rural areas.

THE RATNAGIRI DILEMMA

Objectives

To enable students to
- Weigh alternatives for eliminating a shortage of household fuel.
- Understand some factors affecting adoption of energy-efficient technologies.
- Identify the advantages and disadvantages of biogas.

Subject
Science, Social Studies, Langauge
Group Size
Groups of 12 to 14
Level
Standards 8-10
Materials
Writing materials
Place
Inside the classroom
Duration
45 minutes

Procedure

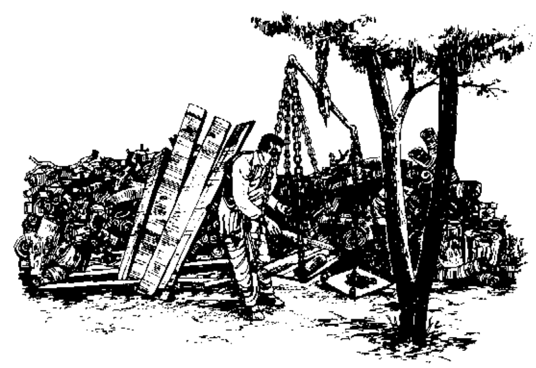
1. Divide the class into groups of 12 students each.
2. Photocopy or write each role on a separate slip of paper.
3. Assign the twelve roles to the members in each group and distribute the role cards. If there are some extra students, ask them to act as "observers" or as "reporters". Ask the students to "get into" the characters assigned to them. Emphasize that the role-play is a serious session.
4. Read out the enclosed **"RATNAGIRI SCENARIO"**. Tell them they have 30 minutes for the discussion. The objective of the discussion is to arrive at ways to reduce Ratnagiri's dependence on fuelwood.
5. After the role-play, does the group think it would be best for Ratnagiri residents to shift to biogas as an alternative to firewood? Ask them to explain their decision.
6. Ask the observers or reporters, if any, to report their observations on the process.

Extension/ Variation

- Ask the students to list the advantages and disadvantages of biogas plants.

Food for Thought

- Keep the vessel covered with a lid during cooking– it keeps the heat in and helps cook faster.
- Don't cook continuously on a high flame. When the liquid in the food starts boiling, the flame size can be reduced. This habit can save as much as 40 per cent fuel!
- A pressure cooker can save up to 75 per cent of the fuel and time spent in cooking.
- For faster cooking, use flat, wide-bottomed vessels which expose a larger area to the flame.
- Turn off the stove a few minutes before the cooking is finished and keep the vessel covered to save fuel.
- Plan and keep things ready before the stove is turned on, to reduce fuel wastage.
- Get the family to eat together–it saves having to reheat food several times.



THE RATNAGIRI DILEMMA

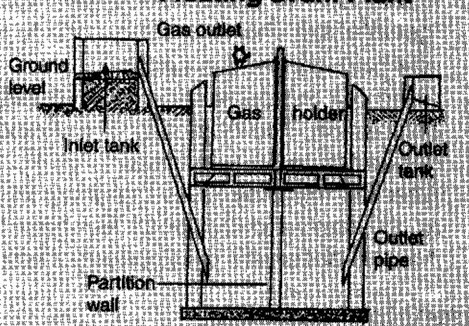
Biogas Plant

One promising technology for increasing the efficiency of biomass conversion is the biogas digester, which converts biomass into modern energy forms.

The biogas digester converts organic matter such as cattle dung or agricultural waste through a process of fermentation into a gas which is 60:40 mixture of methane and carbon dioxide. This gas can be used to cook and to produce electricity for lighting and pumping water. A biogas plant can provide about 25 per cent more energy than burning cattle dung. In addition, the sludge left behind in the digester can be used as a fertilizer which is richer in nitrogen than traditional dung manure.

India has experience of two types of biogas plants– Community Biogas Plant (i.e., in sizes that produce enough biogas to meet the needs of an entire community in a village) and Domestic Biogas Plant (i.e., in sizes that produce enough biogas to meet the needs of an entire family).

Floating Drum Plant



THE RATNAGIRI SCENARIO

Ratnagiri is a small village that enjoyed good forest cover, was rich in a variety of flora and fauna and ample supply of water. In fact, a few threatened wildlife species like the sloth bear were quite common here. The State Forest Department has declared the forest as a sanctuary to protect the threatened bear species. The range forest officer has put a complete ban on the cutting of trees in the forest area. This has resulted in severe shortage of fuelwood and a scarcity of energy resources for cooking.

Fuelwood is the main source of energy for cooking. There is no access to LPG or kerosene in the village, and even if there were, very few villagers can afford these. The villagers have no option but to illegally collect firewood from the forests at night. The villagers have complained to the village leaders in this regard. The leaders have approached the collector of their district to find a solution. The collector has also received complaints from the local forest officer of the threat to the wildlife due to the increasing cutting of wood by the villagers.

The collector feels that some strong steps have to be taken to protect the reserve forest from complete depletion and also for improving the standard of living of the villagers. The collector has had talks with energy experts and he feels that a biogas plant will be a viable alternative in the present situation. The collector has called for a meeting in the village to introduce newer cooking technologies and also stress on the need to adopt the same.

THE RATNAGIRI DILEMMA

THE ROLES

(Write each out on a separate slip of paper and give it to the student to whom the role has been assigned.)

SARPANCH

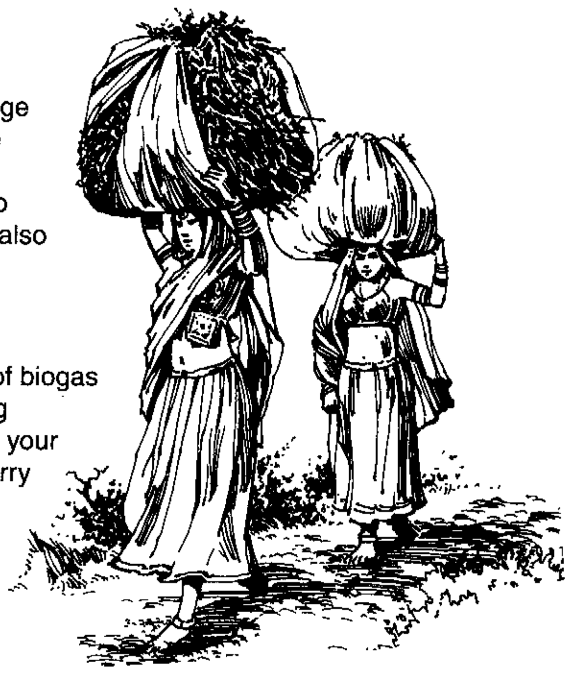
With the new pattern of development, and stress on participation and empowerment that has happened in the villages nearby, you have witnessed the sarpanchs of the village lose their command and respect. You want the villagers to look up to you for fulfilling their needs, thus respecting you. You see no reason why the wood in the neighbouring areas should not be cut by villagers, as it has been for centuries. You have heard that biogas plants installed in the nearby village have not been working after the first few years.

HEAD MASTER

You are the head master of the village school. You want that all the children of the village should get proper education. You are upset with the fact that the girls are not able to attend school, as they have to go far to fetch fuelwood for cooking. You feel that introduction of new technologies will not only improve the standard of living in the village but also help to elevate the status of women.

REVATI, A RATNAGIRI RESIDENT

You are Revati, a newly married educated girl. You have completed SSLC prior to your marriage and lived in a village that has a community biogas plant. You have used it in the past and you know how it has made cooking easier and cleaner. You feel that the people in Ratnagiri should shift to such newer technologies as they help save fuelwood and also improve the quality of life.



SUGANTHI, A RATNAGIRI RESIDENT

You are a resident of this village. You feel that installation of biogas plant will be a big help as it will save you from walking long distances in search of fuelwood. You feel that it will reduce your drudgery and cook food faster. You feel that putting the slurry of cow dung and water in the plant everyday is any day better, easier and less time consuming than going to the forest to gather fuelwood. The fact that biogas could help you cook without any smoke appeals to you a lot.

KRISHNA, A RATNAGIRI RESIDENT

You are a resident of Ratnagiri who is not in favour of the adoption of new technologies. You fear that the biogas plant might burst as the temperature soars high. You fear that your entire family will be in danger if this happens! You feel that as water has to be used in the plant to make the slurry, there is a possibility of shortage of water in the village. Also, you feel that once the dung is used in a biogas plant, it will lose its "strength" to serve as manure. How can something give its "strength" as gas and get "enriched" as a manure?

THE RATNAGIRI DILEMMA

GOVIND, A RATNAGIRI RESIDENT

You are Govind, a young college student. You go to a nearby government college for studying agriculture. You want to see your village use modern technologies and improve the standard of living of the residents of your village. You were fascinated to see your friend make tea for you at the turn of a switch, without any smoke or soot, using biogas, in his village. You wish to see your mother enjoy such comfort in your home too.

CHANDA, A RATNAGIRI RESIDENT

You are a resident who is against the use of biogas plant for cooking. You have heard from friends that cow dung and human excreta are used in a biogas plant for making the slurry. You feel that the food cooked using biogas will have a bad odour and will be impure.

SAKSHI, A RATNAGIRI RESIDENT

You are against the adoption of biogas plant or an improved chulha for cooking. You have heard your friends in the neighbouring villages complain about their dependency on the mason for even minor repairs in their biogas plant. You feel more in control with the traditional chulha as you can repair it yourself whenever needed.

NGO REPRESENTATIVE

You are a sincere NGO representative of an organization that conducts energy conservation programmes, especially in the rural sector. Your prime agenda is to create awareness about alternative technologies available for cooking. You have witnessed the clearing of large forest areas in the region because of the consumption of fuelwood for cooking. You are looking for ways to convince the villagers as to how alternative energy sources will help them meet their energy demands, and also improve their quality of life.

LANDLESS FARM LABOURER

You are a landless farm labourer. You live and work in Ratnagiri for six to eight months a year, after which you move to other places looking for additional income. You feel that if any new technology like the biogas plant is introduced it will be of no help to you. On the contrary, you would have to also pay for setting it up although you would never get to use it for more than half the year. You are comfortable making your own chulha wherever you go.

FOREST OFFICER

You are a sincere forest officer. The residents of Ratnagiri have been regularly cutting wood from the forest to meet their energy demands. You feel that this is increasing the threat on the habitat for the sloth bear. You want the villagers to keep away from the forest by adopting alternate arrangements suggested by the collector.

COLLECTOR

You are the Collector of the district. You feel that it is your responsibility to help the people of Ratnagiri find an alternate energy source and adopt new cooking technologies like a smokeless chulha or a biogas plant.

OBSERVERS/ REPORTERS

You are designated as an Observer/ Reporter for this meeting by the Collector. You are supposed to observe and record all actions and points that help the group to reach the solution during the discussion. You *should not* voice out your opinion or make comments that would distract others.

19 ENERGY PATROL

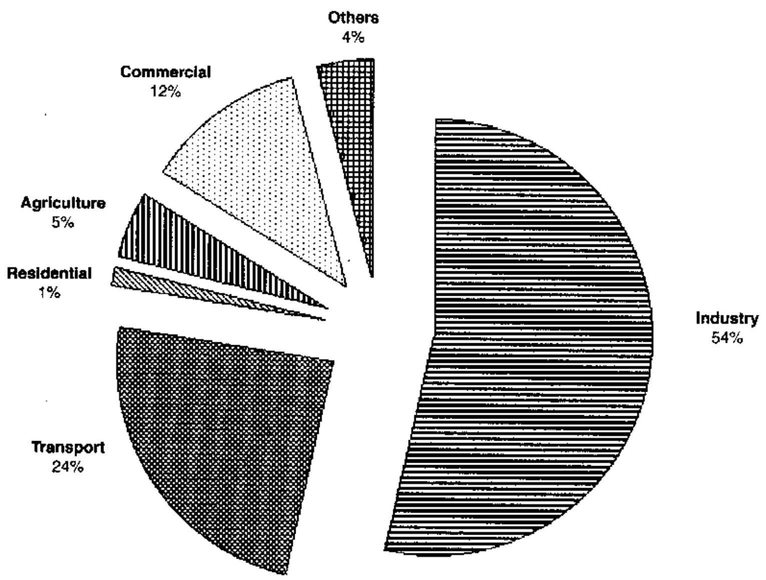
BACKGROUND

Energy conservation means reducing waste today, for a better tomorrow. An important reason to conserve energy is to help reduce the amount of money spent on electricity, petrol and other forms of energy. Energy conservation also helps to save fossil fuels (coal, oil and petroleum) and help reduce the impacts of pollution resulting from energy generation.

Simple actions in daily life can be a beginning towards conserving energy. For instance, one step to saving energy is to cut down on unnecessary lighting. Turning off lights when not in use, using natural sunlight wherever possible, keeping bulbs and fixtures clean and using fluorescent light bulbs help save energy.

To reduce wastage of energy, conservation of energy has to be made a priority. Several ways to reach out to a wide variety of people for communicating the importance of energy conservation is an important step in this effort.

Commmercial Energy Consumption in Various Sectors*



**Apart from commercial energy, a large amount of traditional energy sources are used in India. Till date, nearly 40 per cent of our energy comes from these traditional sources.*

Source : Energy-EnviroScope Manual for College Teachers

ENERGY PATROL

Objectives

To enable students to monitor energy use in the school and take actions to reduce energy consumption and costs.

Subject
Science, Social Studies
Group Size
Entire Class
Level
Standards 8-10
Materials
Writing materials, Energy Patrol Certificates, Energy Patrol Badges
Place
Outdoor
Duration
Ongoing

Procedure

1. After discussions with the Principal and/ or the management, assign the authority to the class to monitor and supervise energy conservation measures and to suggest changes where necessary to reduce energy consumption and costs.
2. Ask the students of your class to form an Energy Patrol to supervise energy consumption and conservation in the school.
3. Together with the students, develop a checklist of areas to monitor. For example, to check for lights and fans left on in empty classrooms, etc.
4. Tell the students that their challenge is to demonstrate a noticeable decrease in energy consumption–made evident through monthly meter readings.
5. Teach the students how to read a meter.
6. Develop appropriate "Energy Patrol Certificates" and "Energy Patrol Badges" for the students.
7. Before the energy patrol team commences its daily duties, ask permission from your school principal and organize a special "energy assembly". During the special assembly, request your principal to make a school-wide announcement to inform the other classes about the patrol, and ask him/ her to honour the members of the energy patrol team with the "Energy Patrol Badges". This would help give the members of "Energy Patrol" the legitimacy necessary for their actions.
8. Each morning select and assign two patrol members who will check to record the meter reading before the school begins and after the school closes, to see how much electricity has been used.
9. Ask the students to collect data for a designated span of time.
10. Ask the patrol team to implement the monitoring of their checklist.
11. Ask the patrol team to work out a reward system for various classes, for example, giving classrooms with lights off a note of appreciation with a happy face, and those found wasting energy a note with a sad face.
12. Evaluate the consumption data collectively with the class, to see if any savings were made.
13. Together with the class, develop recommendations as to how the school can further cut energy costs.
14. Arrange for a special assembly in the school to report the students' findings and to present awards to the most energy-efficient classrooms.
15. During the assembly, recommendations can be made and the entire school can be encouraged to reduce energy consumption through its united effort.
16. Ask the students to report their findings to the principal and on the school notice board, discussing the school's energy use and areas of high-energy loss.

Extension/ Variation

- Ask your "Energy Patrol" to develop cultural programmes or advertisements to convey the messages of energy conservation to the other students.

20 TELL THE WORLD

BACKGROUND

Efficiency means getting the greatest possible amount of output with the least amount of inputs–effort and cost. "Energy-efficient" products such as fluorescent light bulbs provide the same amount of light as the less efficient incandescent bulbs, but they use less energy in doing so. High efficiency fluorescent light bulbs last about 10 times longer than normal light bulbs. They use one quarter as much electricity to deliver the same amount of light. A comparison between a fluorescent light bulb and an incandescent bulb shows that a 75 W filament bulb consumes 75 units for running 100 hours, while a 15 W fluorescent light bulb which gives the same amount of light as a 75 W bulb does, consumes only 15 units. Fluorescent light bulbs contain Krypton and Argon gases which are safe and do not harm the environment.

Another example of an energy-efficient product is an improved chulha. The thermal efficiency of an improved chulha is 20-35 per cent, as compared to that of a traditional chulha, which is only 10 per cent.

Many of us are not aware about a range of energy-efficient products available in the market, and even those who are aware, may not adopt newer technologies. One of the reasons for this could be that energy-efficient products like fluorescent light bulbs cost more initially than conventional products like incandescent bulbs. However, use of energy-efficient products helps save money in the long run and saves energy throughout its lifetime. Use of energy-efficient products like fluorescent light bulbs is one way of saving energy and money in the long run.

Conversion Efficiency of Fuels used for Cooking (Per Cent)

Fuel	Efficiency
Commercial	
Soft coke/ coal	10.0
Kerosene	38.0
LPG	60.0
Electric Hot Plates	71.0
Non-commercial	
Firewood	14.5
Twigs and Straw	14.5
Charcoal	16.0
Dungcakes	08.0
Biogas	55.0

Source : TEDDY 1999-2000

Some Rules for Brainstorming

1. Avoid censoring ideas prematurely.
2. Don't be concerned about whether the ideas are flowing in a logical sequence.
3. Generate as many options as possible during the brainstorming phase. Deal with workability of the suggestions later.
4. Suspend critical judgements on your part that say, "It won't work."
5. Don't be satisfied with the first idea. Push the students to generate other ideas before committing to one.
6. If the students run out of ideas, take a break. Later, try approaching the product from a different angle.
7. When considering ideas, ask yourself and others, "why not"? instead of "why"?

TELL THE WORLD

Subject
Science, Language
Group Size
Groups of 5 to 7
Level
Standards 7-9
Materials
Writing materials
Place
Inside the classroom
Duration
30 minutes

Objectives

To enable students to
- Creatively express their knowledge and learnings related to energy.
- Encourage energy conservation in their community.

Procedure

1. Divide the class into groups of 5 to 7 members each.
2. Tell them to imagine that each group is an advertising agency which has been asked to help publicize one energy-efficient device, for example, a high-efficiency compact fluorescent light bulb, solar cooker, pressure cooker, bicycle, fuel efficient kerosene stove, geyser with a thermostat that helps conserve energy by letting the user set appropriate temperature, a solar lamp, etc. (you may add more devices if necessary).
3. Tell them that as the advertising agency they need to look for:
   a. Information on energy efficiency that they think would persuade consumers to buy these products.
   b. Ways to present a comparison of the energy savings and cost savings of all these devices.
   c. Ways to appeal to people's desires to protect the environment through energy conservation.
   d. Special features of the product.
4. Assign each group one energy-efficient product and tell them their task is to perform the activities of an advertising agency to publicize this product. Allow them to brainstorm about the product (See box "Some Rules for Brainstorming").
   You may suggest to them that they could try any or all of the following:
   - **Designing packaging** The students could design packaging by wrapping plain white paper around an existing package of the product, then decorating it with their advertising slogan, graphics and information.
   - **Creating an advertisement poster** The students could create an advertising poster to be put up in the shops.
   - **Designing an advertisement for a magazine** The students could create an advertisement for a magazine or newspaper.
   - **Acting out a TV Commercial** The students could create and act out a TV commercial advertisement or develop a jingle.
5. Before the students break into teams, select a couple of advertisements in some popular magazines to examine the list of elements in each advertisement.
6. Tell the students that their advertisements should answer the following questions:
   - What is the product?
   - What does it do or what is it used for?
   - Why is it preferable to use this product? What are its advantages?
7. Let them put up an exhibition of these for the rest of the school.

Extension/ Variation

- Have the students write an essay on one of the following:
  a. The importance of conserving electricity.
  b. How I can encourage other people to use less electricity.
  c. What I and others in my family can do to use less energy.

21 DEBATING THE ISSUES

BACKGROUND

India is among the 10 most industrialized countries in the world. Consumption of energy in industries and in other sectors is fast increasing. In generating and using energy however, not only are non-renewable resources consumed, pollution is also caused.

Environmental pollution is the introduction of chemicals or agents which can cause health problems in life forms, and human beings into the physical environment, that either did not exist or did not exist in the same large scale, earlier. The impacts of pollution of resources like pure air (indoor as well as outdoor), soil and ground and surface water resources, on the environment and on the health of human populations is considerable, and growing. Some of the pollutants related to energy generation which adversely affect human beings and environment are:

Suspended Particulate Matter (SPM) These are particles of dust, soot and grime that are sent into the air by almost anything that burns, for example, the coal in the power plants that generate electricity. It is also emitted from the exhaust of millions of cars, scooters and buses. SPM coats the lungs and can trigger respiratory infections, asthma and throat irritation.

Lead It is a toxic metal present in normal petrol and is emitted as fine particles in vehicle exhaust. It affects the central nervous system, causes renal damage and hypertension.

Carbon Monoxide It is a colourless, odourless gas. It is produced by the incomplete combustion of fuels. It causes headache and also reduces the ability of the brain to work normally. It also reduces the ability of the blood to carry oxygen.

Sulphur Dioxide It is a colourless gas which is a part of diesel exhaust and factory emissions. It affects the upper respiratory tract and causes bronchial problems, nose blockage and cough. A bigger problem associated with sulphur dioxide is that when it gets mixed with the water in the sky, it forms sulphuric acid and comes down on the earth with the rain in the form of acid rain. This can kill the creatures in lakes and rivers, and harm vegetation.

Nitrogen Oxides These are formed during fuel combustion in motor vehicles and power stations. They react with volatile organic compounds in the presence of sunlight and heat to form smog. They lead to stinging eyes, coughing, increased asthma attacks and greater susceptibility to infections. They are also toxic to plants.

DEBATING THE ISSUES

Objectives

To help students
- Explore certain issues related to energy conservation, pollution, etc.
- Express effectively their knowledge and learnings related to energy.

Subject
Science, Language
Group Size
Entire class
Level
Standards 7-9
Materials
Writing materials, access to information on the issues
Place
Inside the classroom
Duration
30 minutes to 1 hour

Procedure

1. Announce a debate on one or more energy related topics such as:
   a. India should take immediate and forceful steps to ban use of diesel vehicles for personal transportation in an effort to reduce air pollution in cities.
   b. India should go for more nuclear power plants to reduce air pollution.
   c. India should go for more large dams as hydroelectricity is one of the least polluting energy sources.
   d. Since the rate of increase of power consumption is highest in the industrial sector, we should worry only about this sector. Energy conservation in other sectors (e.g., commercial, agricultural, residential, etc.) is not of great importance.
   e. There should be a complete ban on the use of personal vehicles in cities.
2. Ask the students to research and collect information on the topics assigned.
3. Give a week's time for the students to prepare for the debate and to collect information.
4. Tell the students to note down the important points they identified to support their view.
5. Organize a debate in your school and ask the students to present their learnings on the topic.

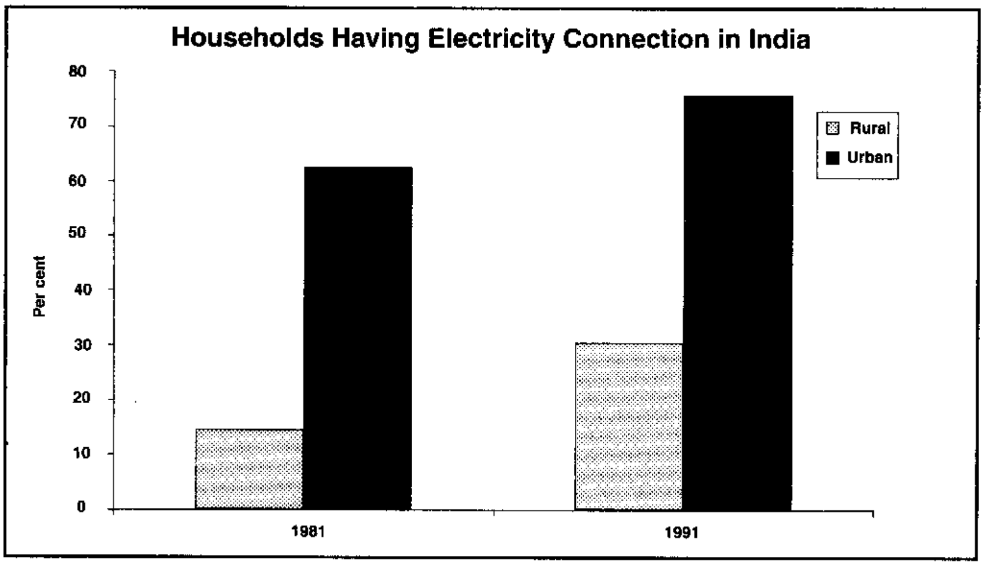
Extension/ Variation

- Ask the students to present their research findings on a school bulletin board after the debate.

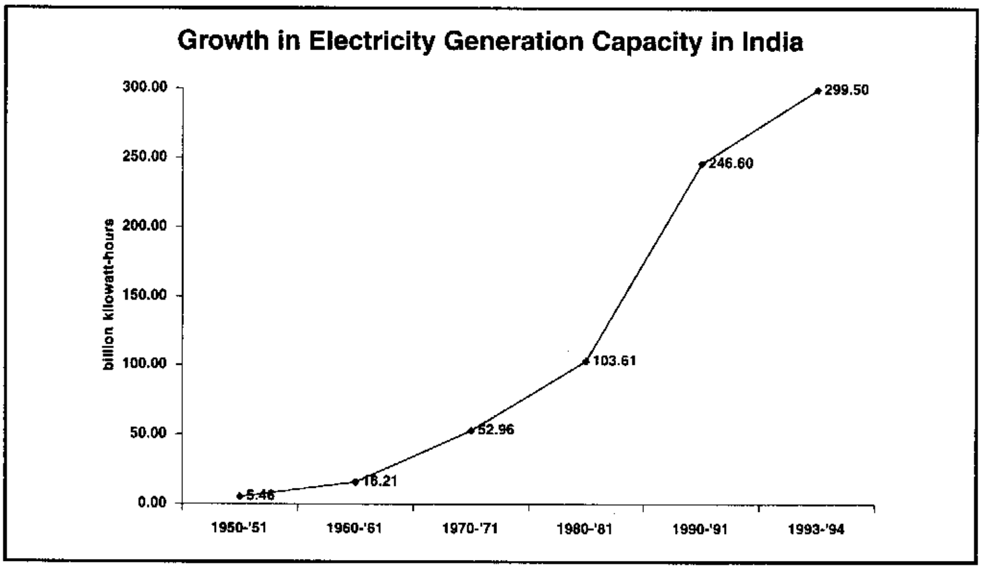
22 THE BIG BIJILIBEN!

BACKGROUND

It is a common experience to be plunged into darkness for hours due to power breakdowns. One of the reasons for such power failures is the high demand for electricity as compared to the total power generation.The increasing demand will be obivous from the following examples: In India, the use of electricity for lighting has increased by 22 per cent in the rural areas and by about 19 per cent in the urban areas within a period of 10 years from 1983-'93. There has been a decrease in the number of households using kerosene for lighting both in the urban and the rural areas. Electrification of rural households have recorded more than a twofold increase, and there has been a 14 per cent increase in the electrification of urban households.



Source: TEDDY 1999-2000



Source: The Citizens' Fifth Report - Part-II Statistical Database

THE BIG BIJILIBEN!

Objectives

To enable students to creatively express their knowledge and learnings related to energy.

Procedure

With your students enact "The Big Bijiliben".

There are seventeen characters viz.,

A. Power Sources
1. Kolsaraj
2. Surya
3. Uri Uranium
4. Gaswallah
5. Oily
6. Hydropowerful

B. Shakti's Family Members

7. Mrs. Shakti
8. Mr. Shakti
9. Kavita Shakti
10. Manish Shakti
11. Raju Shakti
12. Sarita Shakti

C. Effects

13. Water Pollution
14. Air Pollution
15. Radioactive Waste

D. Others

16. Satya
17. Bijiliben

Other students can take responsibilities like, direction, costumes, sets, etc.

Subject
Science, Language

Group Size
Entire class

Level
Standards 7-10

Materials
See "Props"

Place
Inside the school

Duration
30 minutes plus time for practice

PREPARING THE STAGE

The skit can be presented either in a classroom or on a stage. Divide the stage area in half. Keep the Shakti family and their appliances slightly to the rear, and keep the energy action in front of them. That way, the Shakti family will always be visible, and as their appliances stop working, the audience can readily see what is going on.

PROPS

Do not use real appliances. Cut out the appliances from cardboard and paint them. The actors can simply lay them face down on the stage floor when they stop working. However, if it seems too time consuming to make models of electrical appliances, you may want to bring in real appliances and tape their power cords to the stage floor, rather than actually plugging them in. Students could also make posters which show how the various types of power plants work. These posters are mentioned in the script. A drawing of a plug point would also be useful.

THE BIG BIJILIBEN!

COSTUMES

Simple costumes will help remind the audience of the identity of the players. Bijiliben, the Power sources, and the other non-human characters could wear brown wrapper paper with holes cut for head and arms, clearly labelled with a drawing and a simple sketch. For example, Kolsaraj's shirt or bag could be labelled with the word "COAL". A lightning bolt could be drawn on Bijiliben's dress. Gaswallah could wear an illustration of a blue flame on his shirt. Hydropowerful could have a dam or flowing water. The lettering and drawing can be done on a piece of white paper which is then pinned to the dress.

SCENE ONE: KNOW YOUR BIJILI!

(In front of the curtain — if there is no curtain, at the front of the stage.
Bijiliben races for a few minutes from left to right of the stage. Finally Bijiliben stops running and addresses the audience.)

Bijiliben : Hi! You all know me. I'm Bijiliben! *(Bijiliben shades her eyes and strains to look out at the left, right and middle of the audience).* Don't give me that blank look! We are old friends. If it wasn't for me, the lights would go out.

(All the lights do go out, then come back on again).

See what I mean. I make your life at school and your life at home easier. Let's sneak a peek at the Shakti home and see how they use me.

SCENE TWO: THE INVINCIBLE BIJILI

(At the home of the Shakti family. Mrs. Shakti is working at the computer. Her eldest daughter, Kavita, is drying her hair with a blow dryer while reading a book under an electric light. Her eldest son, Manish, is listening to the radio while doing his homework under a desk lamp. There is an air cooler on in his room. Her younger son, Raju, is watching television. The youngest daughter, Sarita, is playing games on another computer. Mr. Shakti is working on some furniture with an electrical drill.

Bijiliben stands at the side of the stage, watching this scene with the audience.)

Sarita : *(Leaving her computer on as she goes to sit with Raju.)* Will you change the channel? "Shaktimaan" serial will be on in a few minutes.

Raju : No way! I am watching this movie.

Sarita : *(Gets up and goes to talk with her mother)* Amma, will you read me a story?

Mrs. Shakti : Not now, dear, Why don't you go and have some halva? It's in the refrigerator.

Sarita : Okay.

(On her way to the kitchen feeling disappointed, she meets Manish in the kitchen.)

Manish : Hey, Chutki!

Sarita : Don't call me that.

Manish : *(Going to the stove to boil water)* Want some hot chocolate?

Sarita : No, but will you read me a story?

Manish : Sorry, I have got a lot of homework tonight.

Sarita : *(Goes to see her father)* Daddy!

Mr. Shakti : What's it, Chutki?

Sarita : *(Making a face because she hates being called by that name)* Will you read me a story?

Mr. Shakti : *(Continuing to work)* That's a possibility.

Bijiliben : *(To the audience.)* Look at them. They don't even remember that I am here. Now, watch what happens when I disappear.

(All the lights go out. There is silence for a moment.)

Sarita : What happened?

Mr. Shakti : We must have blown a fuse!

Sarita : Look outside, Daddy. The neighbours' lights are out too!

Mr. Shakti : Then there's either a power line down somewhere, or we are having a blackout. *(Mrs. Shakti turns on a torchlight and the family gathers together in the middle of the stage.)*

Mrs. Shakti : I called the power company. They say that the electricity should be back on in a few hours. There was an overload.

Kavita : I haven't finished drying my hair. It's going to look awful.

Raju : That was the best movie! Now I won't know how it ends!

Mrs. Shakti : I lost a whole document on the computer. If only I had saved it before the power went out.

Manish : I have a big test tomorrow. How am I going to study for it if we only have one emergency lamp?

Mr. Shakti : Well, let's make the best of a bad situation. What can we do while we wait for the electricity?

Kavita : I don't know.

Raju : I'm bugged!

Sarita : Manish, tell us a ghost story!

Raju & Kavita : Yeah!

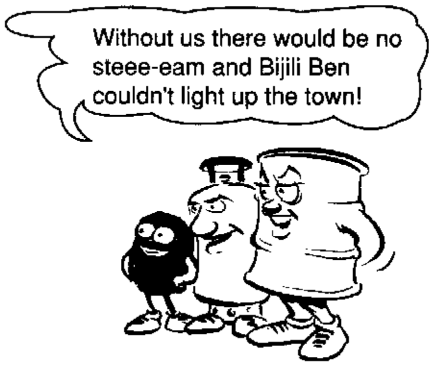
(As they gather around Manish, Bijiliben returns to center stage.)

THE BIG BIJILIBEN!

SCENE THREE: THE TROUBLE WITH THE BIJILI MAKERS

Bijiliben and the power sources *(The members of the Shakti family may either be offstage for Scene Three, or they be on stage but in the dark).*

Bijiliben : Now maybe I will get some respect around here. It bothers me the way people use me all the time, then forget I am even here. *(Speaks to the audience).* Now maybe you are different. Maybe you have stopped to think about where I come from. You know, many people in our country even today live in homes that do not have electricity. Don't assume that everyone has little outlets, plug points *(holds up a drawing of a plug point)* in their walls for me to come out for TVs, VCRs, washing machines, grinders, mixers, hair dryers, refrigerators, fans *(stops and gasps for breath)*, computers and... what not! So those who have electricity shouldn't use it wastefully. Some genius figured out how to produce me and send me into your homes through these little outlets *(points out the plug point)*, but I bet you can't guess how I get to all these outlets. Don't worry, I will show you. Here let me introduce you to some of my friends. Oily, come out here.



(Oily proudly makes a grand entrance.)

Oily : Hi Bijiliben!

(She vigorously shakes hands with Bijiliben and then gestures to two friends–Gaswallah and Kolsaraj. They run and join him/ her.)

Bijiliben, let me introduce you to two of my best friends. We always do things together and we are very alike.This is Gaswallah, he's made of natural gas and this is the great Kolsaraj.

Gaswallah and Kolsaraj : Hi Bijiliben!

Bijiliben : You know, Oily, Gaswallah, Kolsaraj, I am crazy about the three of you. Tell the audience out there what I am talking about.

Oily : No problem. See, everybody, we really get fired up for Bijiliben!

Kolsaraj : I don't know, Oily, I think we really get "all steamed up", not "all fired up" After all, without steam, Bijiliben doesn't exist.

Gaswallah : Oh! stop quarrelling. You are both right *(Gaswallah pulls out a poster of an electric power plant and holds it up).* We burn to make heat; the heat boils water to make steam; the steam turns a turbine; and the turbine turns a generator. It goes something like this...

THE BIG BIJILIBEN!

(Singing together)

Without us there would be no steee-eam.
And Bijiliben couldn't light up the town.

(Enter Uri Uranium, in a huff and obviously upset.)

Uri : Hey! hey! hey! Hold on there you three before I split an atom! What's that statement you made? Did I hear you say that "without us there would be no steeeeeam, *(in a sarcastic manner)* so Bijiliben couldn't light up the town?"

Kolsaraj : Yes we did, and what's it to you, Uri Uranium?

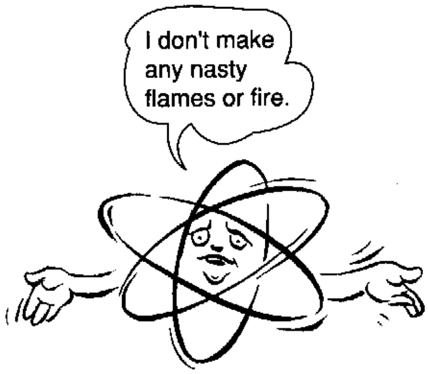
Uri : Well, what about me? You are not the only sources of energy around here. I am just as good as you at making heat and boiling water for steam. The biggest difference between me and you in fact is that I don't make any nasty flames or fire. My nuclear reactions give off enough heat to boil water ... and I get even hotter than you do.

(Bijiliben pats Uri on the back sympathetically.)

Gaswallah : You are right, Uri. We just forgot about you because you don't burn the same way we do. You split atoms in a nuclear reaction to make heat, and we burn with a hot fire. Sorry, yaar!

Oily : That's right, Uri, We are sorry. We four have got to stick together; without us, human beings wouldn't have Bijiliben in their buildings.

Kolsaraj : They would have to live in the dark at nights.



(The four power sources put their arms around each other's shoulders and stand in a line, kicking out their legs and having fun. Hydropowerful enters the scene quite agitated that her role wasn't recognized.)

Hydropowerful: Hey you four!... Sure, may be you make heat to make steam to turn a turbine and generator, but when Bijiliben uses me, she doesn't need any steam!

(Putting his/ her arm around Bijiliben, swaying with Bijiliben as if there is music in the background, and speaking in a romantic tone.)

When I fall down a waterfall, over the blades of a turbine ... It's music... It's poetry ...
And it brings Bijiliben right to life. No fire, no smoke, no pollution... just electricity.

(There's a rustling noise off stage.)

Oily : What's going on out there?

Kolsaraj : *(Sarcastically)* Oh, it's that young guy, Surya, "Saviour of the earth". Ok, guys, let's try to be nice.

(Surya enters the scene quite in a hyperactive style and agitated that his/ her role wasn't recognized.)

THE BIG BIJILIBEN!

Surya : I have had it up to here! All of you think you are so all-fired important. Ha! When I am around, Bijiliben comes to life with no turbine, no smoke, no fire, no steam, no generators, no nothing — just good, clean plentiful sunshine. That's right! When I get together with the sun, Bijiliben comes right out of the wires to light up lamps! You are all have-beens.

(Surya takes Bijiliben and they dance around the stage together.)

Kolsaraj : Oh, quit making a scene.

Gaswallah : *(Grabbing Surya's arm to stop the dancing)* Yeah, Surya. Cool it.

Surya : Well, some day you dinosaurs will appreciate the energy source of the future–me.

Oily : What a snob!

Bijiliben : Stop it! Stop it! You are all my friends. You all work so hard to create me.

(Kolsaraj, Oily, Gaswallah, Uri, Hydropowerful and Surya all look at each other and burst out laughing.)

Kolsaraj, Oily, Gaswallah, Uri, Hydropowerful, and Surya :

You are right, Bijiliben. We were fighting for no reason.

(They all start patting each other on the back.)

Surya : After all, we all have the same purpose, and that is to create you, our beloved Electricity.

Oily : Uh, oh, everybody. Here comes Satya.

(Satya enters dressed in all white to symbolize truth and purity.)

Everybody : Oh, no!

SCENE FOUR: THE ARGUMENT

(The characters portraying the various fuels remain in place. The Shakti family is on stage. The blackout is over and they are sitting at their electrical appliances once again. As each type of energy is criticized, an appliance stops working. One by one they put their appliances aside, cover them up, or place them face down on the stage. One by one the family members sit down, depressed because their favourite machines no longer work.)

Satya : *(Entering)* All right, everybody, break it up.

Bijiliben : Hey Satya, we are a little busy at the moment. Why don't you go visit some other skit?

Satya : You can't avoid me. I am Satya, I'm the truth, reality!

(Bijiliben begins wringing his/ her hands and pacing nervously. The other characters also look worried.)

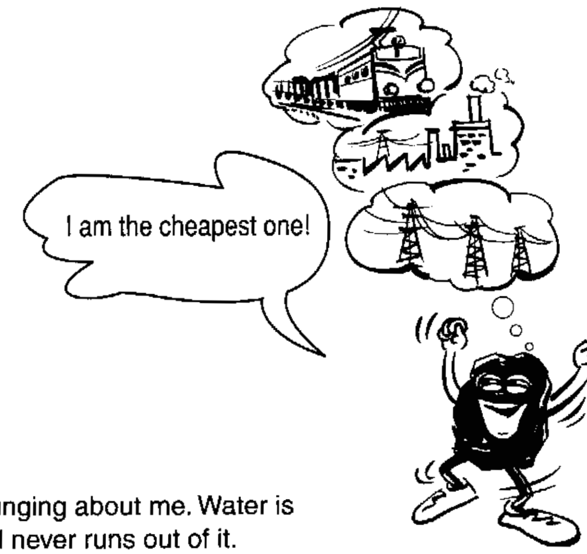
All right, Oily, since you are such hot stuff, let's start with you. What's this I have been

THE BIG BIJILIBEN!

Satya : Oh, Boy! Now that we have put them in their place, let's have a little entertainment. Hey, Air Pollution, Water Pollution, and Radioactive Waste, why don't you come on over here and sing a little song.

Air Pollution, Water Pollution, Radioactive Waste : Okay. We will sing you our very favourite.
(Singing and line-dancing the following song set to any appropriate popular tune.)

Give me that sulphur emission,
Oh! Give me that old time pollution.
Oh! Oh! Give me that old time pollution
It's good enough for me.
Oh, give me the waste from nuclear fission
Oh! Give me that old time pollution
Oh! Oh! Give me that old time pollution
It's good enough for me
Who cares about earth's condition?
Oh! Give me that old time pollution
Oh! Oh! Give me that old time pollution.
It's good enough for me.
(Loudly) DOOO YOUUUU CAAARREEEE ?



(They dance offstage singing the chorus.)

Hydropowerful: Well, they are obviously not singing about me. Water is extremely clean and the world never runs out of it. Hydroelectricity is the cleanest!

Satya : True, but every time a dam is built to generate you, it destroys the natural ecology of the land. You make hundreds and thousands of people lose their homes too! Forests are lost and wildlife is left without a home. How can the little fishes swim along undisturbed when you are in the way? Storing all that water in a dam can be dangerous — leading to risk of earthquakes in certain places. What's more, most of the major rivers on earth that could be used to run hydroelectric power plants have already been developed. You are a has-been!

Hydropowerful: I'm no has-been.

(Bursts into tears and rushes offstage. Another appliance stops working in the Shakti's' home.)

Surya : If hydroelectric power is a has-been, then I am a will-be. I am the energy source for the future and forever. I am very clean. I don't pollute at all. I can produce Bijiliben anytime and anywhere!

Satya : Wait one second! Anytime? And anywhere?

Surya : The sun shines all over the world.

Satya : Yes, only during the day! And on rainy days?

Surya : You can store me the rest of the time!

Satya : But friend, you are incredibly expensive to store!

Surya : People will very soon come out with a technology to store me at a rate everyone can afford.

Satya : Well, that HASN'T HAPPENED yet, and who knows if it ever will?

(Surya angrily walks off stage. Bijiliben sits and sulks. All the appliances have gone off at the Shakti's house. They also sit and sulk.)

Satya : See what happens when these power sources produce you, Bijiliben?

(Satya rubs his/ her hands together and strides confidently offstage. Bijiliben remains on stage, all alone.)

SCENE FIVE: WORKING TOGETHER WORKS!

(The power is back. The Shakti family is back to work and play. Manish and Kavita both work on their homework. Mr. and Mrs. Shakti read the paper. Raju plays a video game. Sarita listens and watches the others.)

Bijiliben : *(To the audience)* Well, Satya can be a real bore. But he left out an important part of the equation: You! You human beings figured out how to generate me and use me to run all your lights and electrical appliances. It took a lot of brain power to do that. So I have a lot of faith in you. I know that one day some of you out there will find solutions to the problems, Satya told you about. *(Pointing to a small child in the audience.)* May be you will invent a way to generate me that doesn't cause pollution. *(Pointing to someone else.)* Maybe you will invent electrical appliances that use less of me to do the same tasks. Well, guess what? There are a number of human beings out there already working on these solutions. Let's see what they have come up with.

(The scene changes back to Mr. Shakti's house, the children discussing with their parents.)

Manish : Mummy, I am stuck. I am supposed to write this report on ways to reduce the amount of pollution coming from fuel-burning power plants and there is nothing about it in the encyclopedia.

Mrs. Shakti : Funny you should mention that. I am right in the middle of an article about electrical power plants that install "scrubbers" to remove sulphur from their smoke. "Scrubbers" can really reduce the emissions that cause acid rain.

Kavita : That sounds expensive.

THE BIG BIJILIBEN!

Mr. Shakti : It is expensive. But in the long run, it might be a lot less expensive than having to fix damage to the environment.

Sarita : Would there be less pollution if we didn't use so much electricity?

Mrs. Shakti : What do you mean, dear?

Sarita : I mean, what if we turn off the lights we aren't using? What if you told me more stories so I wouldn't have to use a lot of electricity playing video games and watching television?

Manish : I think Chutki has got a point there! Would there be less pollution if we used less electricity?

Mrs. Shakti : This article says that the Indian Government is actually encouraging people to conserve electricity. Let me read the article.

Kavita : But won't the government make more money when we use more electricity?

Mrs. Shakti : Oh Yes! But it's more expensive for them to build new power plants and it also causes more pollution. If we don't waste electricity, they won't have to build more power plants.

(Sarita gets up and runs around the house turning off lights and appliances no one is using. She turns off Raju's video game and Raju wrestles her to the floor.)

Raju : Mummy, Sarita turned off the video game in the middle of a game!

(The rest of the family laughs together. When Sarita returns to the others, Raju turns the video game back on again and continues playing.)

Manish : Hey! That gives me an idea for my report! I have an article here about these light bulbs that produce the same amount of light for less energy. Maybe if everyone started using them, the power plants wouldn't have to produce so much electricity.

Mrs. Shakti : Or so much pollution.

Mr. Shakti : Which hurts the planet.

Sarita : And hurts us.

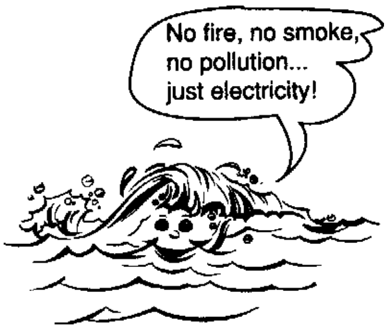
Mrs. Shakti : Well, what it comes down to is, use less electricity and live better.

Sarita : Wow! That's simple!

(Everyone in the family lists something they can do to use less electricity. Sarita begins it with herself.)

From now on I will switch the TV and the music systems off when I don't watch or listen to them.

Raju : I will not use the lift to go downstairs in our flat or anywhere else.



THE BIG BIJILIBEN!

Kavita : I will not leave the refrigerator open when I drink water from it.

Mr. Shakti : I will change all the bulbs in our house into fluorescent light bulbs and help conserve electricity.

Mrs. Shakti : I will go to office by public transport or at least try to pool and share the vehicle with my colleague who lives nearby.

Manish : Well for my share, I will walk down or cycle to reach short distances rather than using my moped. Okay, Chutki! Since you helped me with my report, I will read you a story.

(He settles down with Sarita between their parents)

Sarita : Finally!

Raju : What are you going to read?

Manish : Jungle Book!

Raju : *(Turning off the video game)* Wait for me! *(joins them.)*

Bijiliben : *(Who has been watching this scene proudly)* See, there are solutions to some of the problems you have heard about today. And if you all work together to use me wisely, there won't be so much pollution. Just remember: use me, but don't misuse or waste me!

GRAND FINALE: WE CAN DO IT

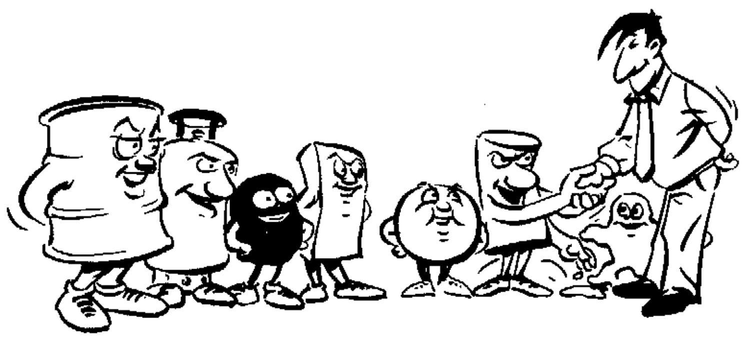
(The entire cast comes on stage to sing. They could put their arms around each other's shoulders and sway to the music of "Hum Honge Kaamyaab" or any other popular tune. The kids at the ends of the lines could hold up fluorescent light bulbs.)

Bijiliben : Everybody! Sing! "We would like to build a cleaner world".

We'd like to build a cleaner world (2)
And conserve energy
Use power carefully
To light up our world
Let us conserve energy
And not use it wastefully

We'll make the earth a better place (2)
For you and for me
In the North and in the South
And in the East and West
We'd like to see the world as one

We'd like to see the world as one (2)
All standing hand in hand
Put your hand in our hand
Help us find the way
Put your hand in our hand
So let us begin today!



23 SUBSIDIZING SUSTAINABILITY

BACKGROUND

A subsidy is a government policy that alters market risks, rewards and costs in ways that favour certain activities or groups. For instance, governments may sell services and resources for less than its cost to provide them, or for less than what they are worth.

For example, in the year 1999 at Delhi

- Kerosene was sold at Rs. 5.46 a litre when it actually costed the government Rs. 10.54 per litre, translating into a loss of Rs. 3,700 crore every year.
- LPG was sold at Rs. 196 per cylinder although it costed the government Rs 294 to supply one. This burnt a hole of Rs. 7,200 crore in government finances annually.
- Diesel was sold for Rs. 8.52 a litre (ex-refinery price) while the cost price was Rs. 10.14 a litre.

Electricity tariffs for the domestic and agricultural sectors are less than the average cost of supply, while the tariff for the commercial, industrial and railway traction sectors are more than the average cost of supply. (Please refer to the table below.)

Percentage of Unit Cost of supply recovered from Consumer Tariff, by Category: 1998 - '99

State Electricity Board	Domestic	Commercial	Agricultural/ Irrigation	Industrial	Railway traction
Andhra Pradesh	71.37	157.18	6.88	141.15	159.96
Assam	34.72	70.62	37.24	55.40	0.00
Gujarat	96.95	161.84	7.63	151.35	160.70
Madhya Pradesh	32.32	146.40	3.95	167.04	229.63
Uttar Pradesh	44.22	146.19	18.92	138.72	158.54
West Bengal	39.12	88.74	12.30	102.30	118.45

Source: TEDDY 1999-2000

Energy related subsidies have environmental and developmental implications and are a significant area of concern.

On the one hand, subsidies may encourage sustainability. For example, the Ministry of Non-conventional Energy Sources subsidizes the use of improved chulhas (cook stoves). On the other hand, subsidies may have undesirable impacts. For example, today in India, domestic and agricultural electricity consumption are highly subsidized, which contributes to over consumption and wastage.

Subsidies may sometimes reach unintended beneficiaries, create unintended incentives, and may burden society with heavy environmental and financial costs.

To be more effective, subsidies need to be more sharply targeted. They should reach only those meant to be helped. They should cease when they are no longer needed. For example, the Ministry of Non-conventional Energy Sources replaced the subsidy on solar cookers in 1994 with financial support for promotional activities. Similarly, the subsidies on solar water heating systems were abolished in 1993 when these technologies attained a certain level of commercialization.

SUBSIDIZING SUSTAINABILITY

Objectives

To sensitize students to various dimensions related to the issue of subsidies for energy.

Subject
Social Studies
Group Size
Groups of 7 to 9
Level
Standards 9-12
Materials
Writing materials
Place
Inside the classroom
Duration
45 to 60 minutes

Procedure

1. Divide the class into groups of 7 students each.
2. Photocopy or write each role on a separate slip of paper. Assign the seven roles to the members in each group and distribute the role cards. If there are some extra students, ask them to act as "observers" or as "reporters". Ask the students to "get into" the characters assigned to them. Emphasize that the role-play is a serious session.
3. Read out the enclosed **"SCENARIO"**. Inform the participants that they will be meeting to discuss the issue of subsidies on kerosene and LPG.
4. Tell them they have 30 minutes for the discussion. Ask the 'Bureaucrat' to start the meeting.
5. Ask the observers or reporters, if any, to report their observations on the process.
6. After the role-play, ask the group to answer the following questions.
   a. Was a decision taken on subsidies?
   b. If yes, what was the decision taken?
   c. If no, why was no decision taken?
   d. Is everyone happy with the decision taken? Why?
   e. What other ways of solving the issue can the participants think of?

Extension/ Variation

- Ask the students to list the advantages and disadvantages of the government's subsidy schemes on energy.

SCENARIO

The government has been giving a 50 per cent subsidy on kerosene and LPG for domestic consumption. There has been a proposal by the government that the subsidy be lifted as the cost of providing kerosene and LPG is causing heavy losses. There has been opposition to this move. In order to get people's views on this issue, a bureaucrat of the Petroleum Ministry has organized a discussion on the issue with relevant people.

SUBSIDIZING SUSTAINABILITY

ROLES

(Write each out on a separate slip of paper and give it to the student to whom the role has been assigned.)

BUREAUCRAT

You are a senior level bureaucrat in the Petroleum Ministry. You are deeply concerned about the fact that the subsidies on kerosene and LPG are causing the government great losses. You feel that subsidy on kerosene may be justifiable because its users are mainly the poor. You feel that removal of the subsidy on LPG may be an option open for the government, as LPG users are largely the middle income group (MIG) and Higher income group (HIG) who may still be able to afford LPG even after the subsidy is removed. However, you feel that there is a need for a discussion on this issue before you take any decision. You have organized a series of discussions at selected places for this purpose. You are keen that the discussion should yield a sound decision.

CHAIR PERSON, CONSUMER EDUCATION SOCIETY

You are the chair person of a reputed consumer education and awareness organization. Your organization conducts sound research and verifies facts before taking up any education and awareness programmes. One of the areas of your work has been energy. You are aware that subsidies on energy are controversial. You know for a fact that the government incurs huge costs every year owing to subsidies on kerosene, LPG, electricity for domestic and agricultural uses. You are also aware that removal of subsidies may impose a huge financial cost on people who may not be able to afford the costs (poor households, poor farmers, etc). You feel that removal of subsidies on kerosene and LPG is a decision that needs to be taken after a detailed study and analysis of impacts–benefits and disadvantages.

MEMBER, CITIZEN'S COUNCIL

You are the member of a citizens' council that is active in voicing citizens' concerns. You feel that it is the government's duty to ensure that basic goods and services are delivered to people at costs they can afford. You feel that subsidies are one of the means of ensuring that poor people have access to goods and services that they otherwise would have been unable to afford. Removal of subsidies on essential goods and services is, according to you, a way by which the government is giving up its responsibility. You are strongly opposed to the move to remove subsidies on kerosene and LPG, which you consider are basic necessities.

JOURNALIST

You are a journalist with a background in economics. You have been interested in the issue of subsidies for a long time. You feel that subsidies are an unnecessary burden on the country. You feel that they encourage overconsumption and wastage of precious resources such as electricity, LPG, diesel, etc. You campaign for removal of subsidies because you feel that they reach the wrong group of people. You strongly support removal of subsidies on LPG as you feel that the MIG and HIG users of LPG do not need any subsidy. You feel subsidies do not make any economic sense–they exist only for political reasons.

SUBSIDIZING SUSTAINABILITY

RURAL DEVELOPMENT WORKER

You are a development worker in a rural development organization. You have been working for the past 15 years in villages. You educate people in villages about the various welfare schemes of the government, so that they can avail of such schemes. One of the areas of your work has been to encourage people to switch from using wood stoves (chulhas) to kerosene and LPG. Several households in the villages you work in have switched over to using kerosene and LPG. You have seen a significant change in these households–the women no longer have to spend several hours each day gathering fuelwood, they have more time to invest in income generation activities. You have also noticed that the wooded areas around the villages are no longer under the threat of getting degraded due to demand for fuelwood. You feel that all these benefits will be lost if the subsidy on kerosene and LPG are removed. You are hence strongly opposed to the removal of the subsidy.

POLITICIAN OF RULING PARTY

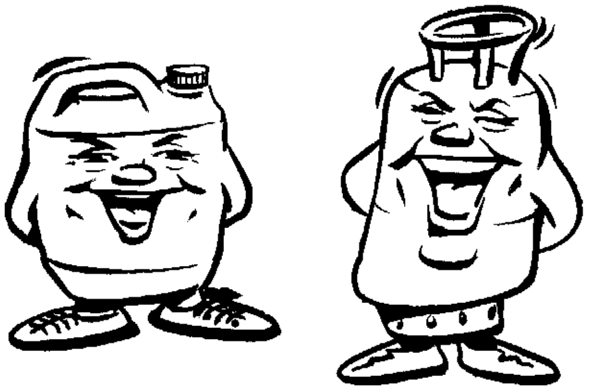
You are a politician belonging to the party which is the ruling party at the moment. You are eager that your government takes decisions which can pull up the ailing economy of the country. You are strongly in favour of removal of subsidy for kerosene and LPG as you feel that this will save a lot of money that can be invested in other deserving social causes like, laying new roads, starting new railway services, building new schools and hospitals, etc. However, you are concerned about how to 'sell' this idea to the public, because it is bound to be unpopular with the public and will cost votes.

LEADER, WOMEN'S WING OF OPPOSITION PARTY

You are the leader of the women's wing of the leading opposition party. You are strongly opposed to removal of subsidies. You are keen to use this opportunity to show that the current government is making decisions that go against the welfare of the people. You are keen to 'expose' this drawback in the present government, as it will improve your chances of winning the next election.

OBSERVERS/ REPORTERS

You are designated as an Observer/ Reporter for this meeting by the bureaucrat. You are supposed to observe and record all actions and points that help the group to reach the solution during the discussion. You *should not* voice out your opinion or make comments that would distract the others.



24 COMPREHENDING CONSERVATION

BACKGROUND

Comprehension is the ability to read, understand, remember, and use information that has been presented. Reading comprehension is an important skill which students need.

To comprehend reading material, it is necessary to pay attention to three elements–vocabulary, main ideas and details.

Vocabulary is an aspect that needs special attention. Many texts present new words in bold print, in the margins, or in a glossary at the back. These words are vital for understanding the entire passage. Glancing over reading material for special vocabulary before beginning to read it, is a useful practice. The definitions of some words can be found in the passage. For some words however, one may have to look up the dictionary. There are many ways of determining the meaning of new terms, one of which is to use context clues.

'Context clues' refers to using information in the sentence or paragraph surrounding a new term to help understand that term. Context clues can be looked for through the following items.

A. A punctuation mark, such as a comma or dash, signals that information is being presented about the new term.
B. Key words, such as "or" and "that is" indicate that a definition follows.

The unfamiliar words should not be skipped. To remember the meaning of new words, making a vocabulary list and writing down their definitions will help.

Reading comprehension can be improved by paying particular attention to new vocabulary, seeking out the main ideas and the supporting details. Most information in the passage is divided into paragraphs. The main idea of the paragraph can sometimes be found in a single sentence, usually the first sentence of the paragraph. This is then followed by sentences containing the supporting details.

To remember information, the students could try the following:

A. Reading the entire paragraph.
B. Writing down the sentence that contains the main idea of the paragraph in their own words.
C. Listing the supporting details, under the main idea.

To test comprehension, some questions, need to be put which ask for information that is not explicitly stated in the material. Answering a question that requires an inference is difficult. It requires careful reading and logical thinking by the students.

COMPREHENDING CONSERVATION

Objectives

To help students
- Learn how to use vocabulary, main ideas, and supporting details to help increase reading comprehension.
- Understand about energy conservation in industries.

Subject
Language, Science
Group Size
Entire class
Level
Standards 8-10
Materials
Writing materials
Place
Inside the classroom
Duration
30 to 40 minutes

Procedure

1. Write the following paragraph on the blackboard or on a chart paper prior to the class.
2. Tell the students that they are going to learn techniques of comprehending information in a given text by doing a few exercises.
3. Ask the students to read the paragraph carefully and answer the questions that follow.

In India, industry is the largest consumer of commercial energy, energy that is bought and sold. It is therefore also the sector, which can make the largest contribution to energy conservation by using energy-saving equipment, and adopting more efficient and sustainable processes and practices. In the industrialized countries a recent focus in the production process, especially of consumer durables, has been on green product design and clean technologies. Products are being redesigned to use material or substitute new materials, which require less energy in their manufacture than traditional materials. Much more attention is also being paid to product life cycle—cradle-to-grave environmental impacts associated with production, packaging, distribution, use and disposal of products.

Energy efficiency refers not only to the efficiency in consumption of energy, but also to efficiency in its generation and distribution. In factories and thermal power plants, cogeneration—production of two useful forms of energy from the same process— units could be installed. In electricity production in India, at present nearly three-fourths of the energy input is lost as "waste heat". This waste heat from coal-fired and other industrial boilers which is in the form of high temperature steam, could be run through turbines to generate electricity. About 10 per cent of the electricity requirements of the textile industry could be met if mills that use steam install cogeneration equipment.

Industry essentially is an economic activity guided by principles that are perceived to make economic sense. Manufacturers will therefore make investments in energy efficiency only if it leads to economic benefits by reducing energy consumption or other quantifiable costs or by increasing quantifiable benefits. For many industries the introduction of innovative technologies that prevent or reduce pollution and lower the cost of complying with anti-pollution laws also tends to decrease energy consumption.

Industries that produce the most pollution, such as chemical, petrochemical, iron and steel, textile, pulp and paper, also consume the most energy. In the present scenario, when the courts are coming down heavily on industries for noncompliance with pollution control laws, it makes economic sense to adopt new technologies and improved practices aimed at pollution prevention and waste minimization that would reduce pollution remediation costs as well as consumption of energy.

Answer the following questions regarding the information presented in the above passage.

1. Why is energy conservation in the Indian industrial sector important?
2. What are some steps being taken in the manufacturing industry towards energy conservation?
3. What is meant by "cogeneration"? How does this help in energy conservation in industries? Name a few types of industries where this is possible.
4. Explain the following terms or words in your words, and use in sentences.
   a. conservation **b.** pollution **c.** non-compliance **d.** energy efficiency **e.** clean technologies
5. Give an appropriate title for the passage.

Extension/ Variation

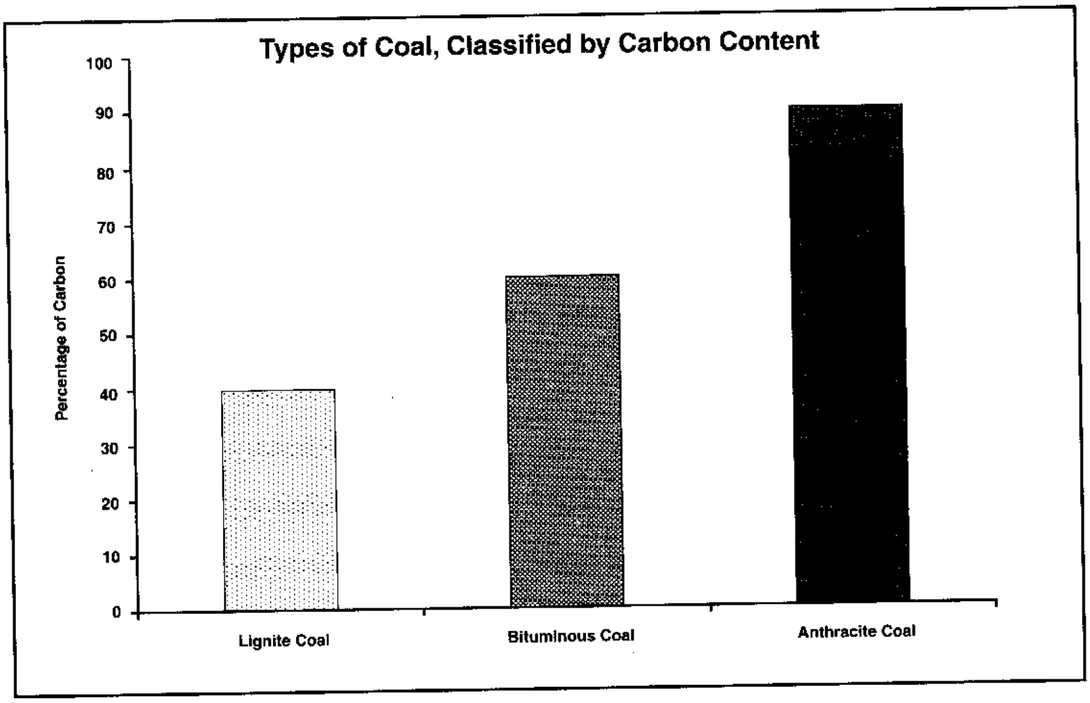
- Ask the students to list why energy conservation in industries is important.

25 THINKING GRAPHICALLY

BACKGROUND

Information presented in the form of graphs is often easier to understand and remember than information presented as a mass of facts and figures. Read the passage "Coal" below. Then see graph "Types of Coal, classified by Carbon Content". Which is easier to understand?

Coal *There are several different types of coal. Coal is classified by the amount of carbon present. Lignite coal has 40 per cent carbon, bituminous coal 66 per cent carbon, and anthracite coal has 90 per cent carbon.*



Compared to text, graphs are clear, concise, and quickly reveal the relationship between the various variables. There are three basic types of graphs that are most commonly used. These are as follows:

Pie Chart A pie chart, sometimes known as a circle graph, is used when parts of a whole are represented. These charts are especially popular when breaking down percentages. The whole circle represents 100 per cent, while each section represents part of the whole. Each part may be labelled with a specific percentage. If not, you can still make comparisons by examining the size of each part in relation to others.

Bar Graph A bar graph presents separate groups of information in a format that allows for comparison. The bars may be horizontal or vertical.
Special attention needs to be paid to the labelling on a bar graph. What is the starting point? How much does each increment represent?
Refer back to Example. The starting point of the graph is at 0 per cent carbon. Each increment represents 10 per cent.

Line Graph A third type of commonly used graph is a line graph. A line graph shows trends and is often used to show changes over time.

THINKING GRAPHICALLY

Subject
Mathematics, Science
Group Size
Groups of 5 to 7
Level
Standards 6-8
Materials
Writing materials
Place
Inside the classroom
Duration
45 to 60 minutes

Objectives

To help students
- Understand the importance and use of various types of charts and graphs.
- Analyze some energy related data presented in graphs.

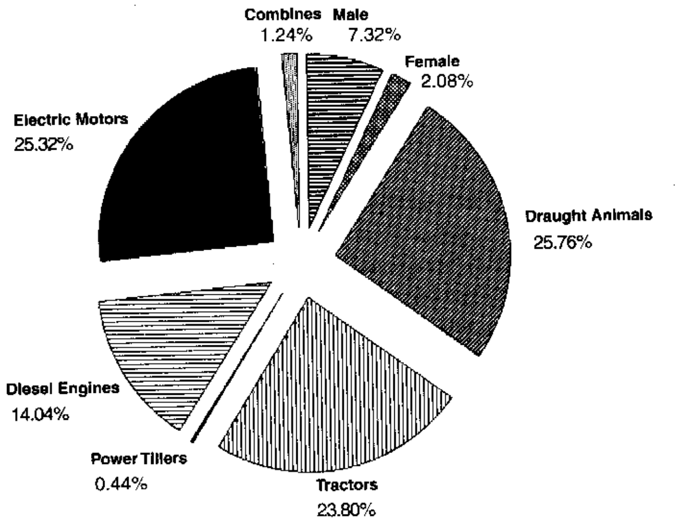
Procedure

1. Divide the class into groups of 5 to 7.
2. Photocopy the graphs given below and give one set to each group. Alternatively, reproduce them on the board or on a chart paper.
3. Tell the students that they are going to do a few exercises based on these.

Exercise I

i. Ask the students to examine the pie chart given below carefully and state whether the following statements are true or false and to correct the false statements based on the information depicted in the graph.
   a. The contribution of energy from animal labour is greater than from tractors on Indian farms.
   b. The share of energy from human labour is greater than that from electric motors.
   c. The input of power for farm activities from human labour and draught animals is greater than from diesel engines and electric motors.
   d. Electricity and diesel engines contribute almost 60 per cent of power for activities on farms.
   e. The contribution of power from tractors is greater than from electricity for activities on farms.

Contribution of Various Energy Sources to Indian Farm Power: 1991-'92

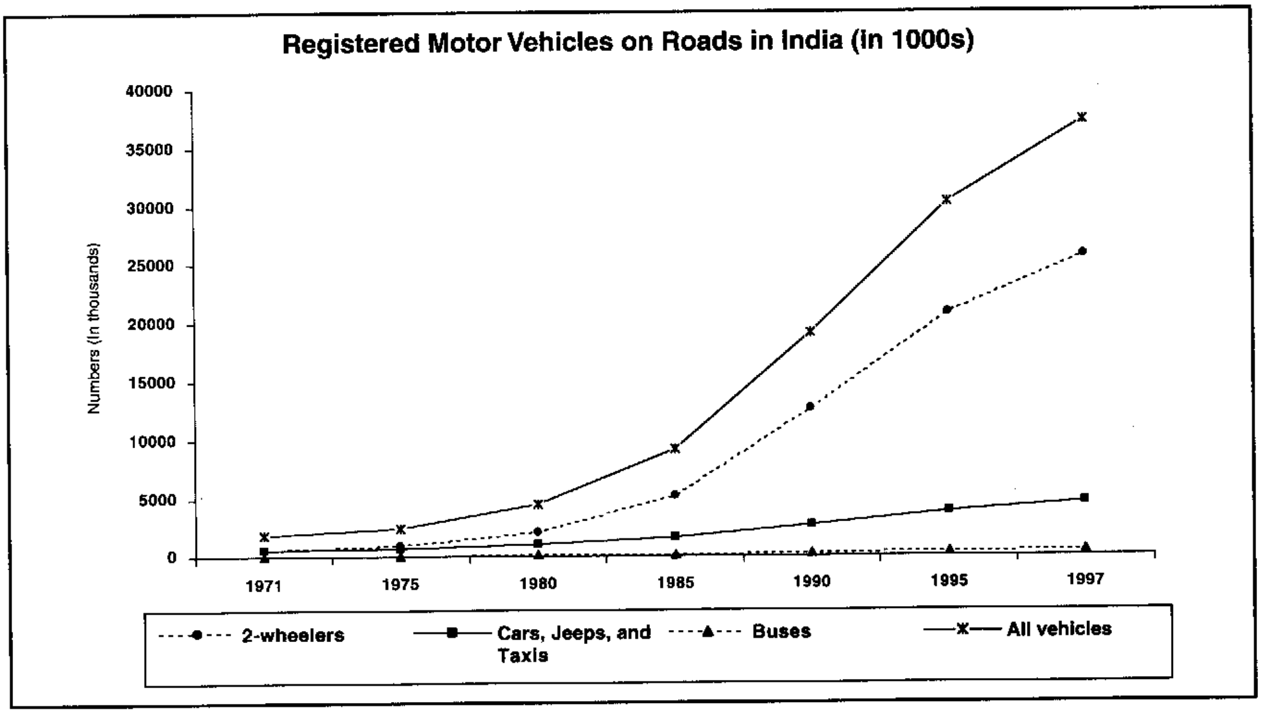


Source : TEDDY 1999-2000

Exercise II

i. Ask the students to examine the line graphs and to fill in the blanks in the statements given below.

a. ___ is the type of vehicle that increased most in numbers between 1971 to 1997.
b. ___ is the type of vehicle that increased in numbers least between 1971 to 1997.
c. ___ is the vehicle type that increased in numbers most after 1990.
d. ___ is the vehicle type that was most commonly used for transport until about 1985.
e. ___ was the 5 year period when the number of vehicles on roads almost doubled.

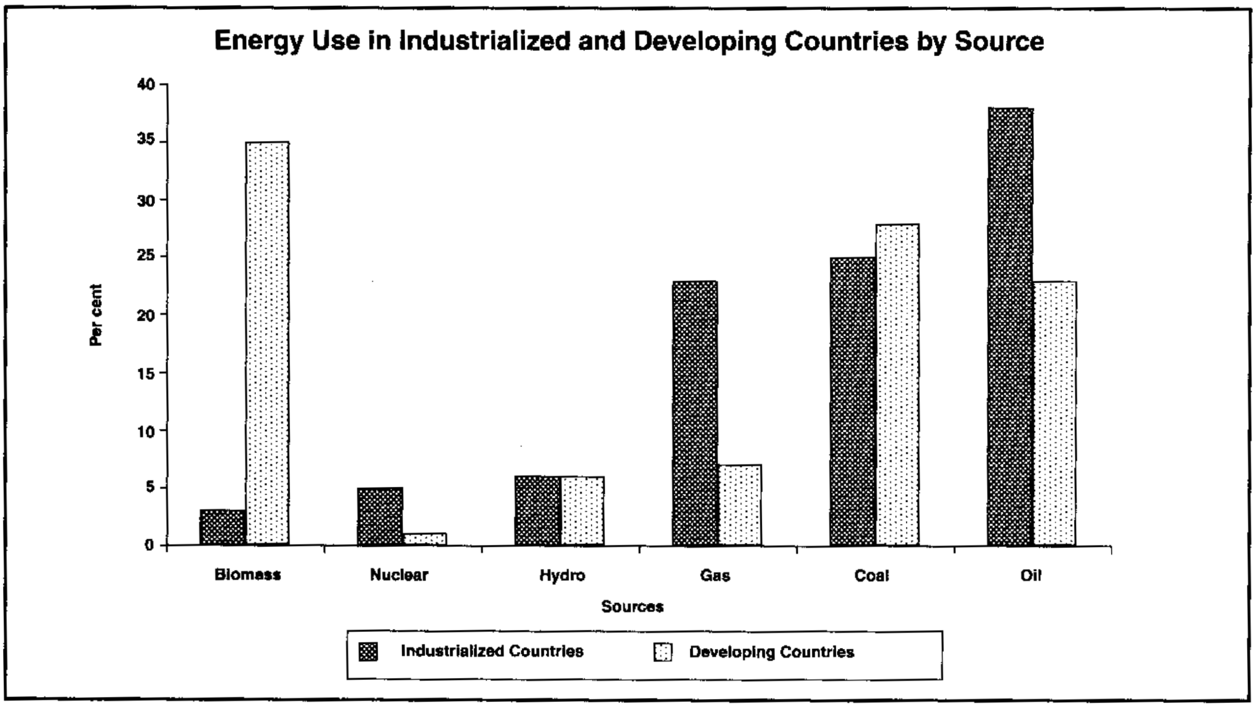


Source : TEDDY 1999-2000

Exercise III

i. Ask the students to carefully examine the bar graph given below and answer the following using the information depicted in the graphs.

a. Which countries depend more on non-renewable resources–industrialized or developing countries?
b. Which kind of countries would have to worry more about radioactive waste disposal?
c. Hydro-power is more important in industrialized countries. True or false?
d. Women in developing countries are likely to spend more time in collecting fuelwood. True or false?



Source : Energy-EnviroScope Manual for College Teachers

Exercise IV

i. Ask the students if the choice of graph in each case is correct. If they were given an option, how would they have depicted the data?

Extension/ Variation

Ask the students the following questions:

- Give energy related examples of when it is best to use each of the following types of graphs:
  a. pie chart b. bar graph c. line graph
- Read the following information and represent it in the graph form you think will portray this information best. Say why you have chosen this type of graph.

  You spent Rs. 2,400/- on electricity bills this year as given below. You would like to discuss with other members in your home how to reduce the bills for the next year.

January	Rs. 230	February	Rs. 220	March	Rs. 190	April	Rs. 220
May	Rs. 240	June	Rs. 240	July	Rs. 220	August	Rs. 200
September	Rs. 210	October	Rs. 220	November	Rs. 230	December	Rs. 240

SUCCESS STORIES IN ENERGY EDUCATION

SCHOOL ENERGY PROJECT, AHMEDABAD ECO-CLUBS

An eco-club is a voluntary association of students which promotes their participation in action projects on environmental issues and thereby helps them to learn about and improve their immediate environment. Centre for Environment Education (CEE), a national institute situated in Ahmedabad, India, has a network of eco-clubs in and around Ahmedabad. In association with Green Schools project, Alliance to Save Energy, Washington D.C., USA, the theme of energy education was taken up for eco-club activities from 1997 - 2000.

The "information to action" approach taken by the programme encourages eco-club members to study and understand problems and then develop and undertake action projects. The programme components include:

Teacher Training Teachers in the schools are involved in planning and conducting the activities through weekly meetings. Hence, CEE's first intervention is capacity building the concerned teachers. Issues such as membership to the eco-clubs, selection of members, operationalising of the eco-clubs in the schools, reaching out and networking strategies for the eco-clubs to optimise its reach and resources, form the agenda of the workshops. Content–relevant exposure and training in environmental education approaches are integral to these training workshops. The output of these workshops is an annual plan of action for the club.

Action in Schools The eco-clubs use all available platforms within the school structure such as the bulletin boards, assemblies and annual functions to spread the message of environment conservation. The newsletter, wall paper, activities such as the chain letter and eco-club annual events such as rallies, fairs and cultural programmes have been used to involve the whole school and parents. Electricity audits in homes and subsequent energy saving measures through behaviour modification have helped the eco-club members save upto 15 per cent electricity costs. In schools, the eco-club members have formed check teams to help conserve energy and water. Reubs School maintains regular charts in each classroom of lights and fans left on. In C.N. Vidyalaya, the eco-clubs regularly presented their activities and conservation tips in the school assembly.

Energy Rooms in Schools Energy rooms have been set up in three schools to allow the eco-club members and other students in the school to get a hands-on experience. The energy rooms have games, renewable energy products such as the solar cooker, solar lantern and energy resource material, all contributed by the Gujarat Energy Development Agency (GEDA). The Ahmedabad Electricity Company has provided one of these energy rooms an electric meter for comparitive readings of different electrical gadgets. Such a resource centre can be of service to a number of schools in the vicinity.

Mid term evaluation and planning meetings for teachers at CEE help make mid-course corrections.

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Special programmes for the members Vacation leadership training programmes for student members have provided the teachers with much needed support to conduct their activities and have given the members the opportunity to contribute to the planning of activities in their school. Capacity building of the members through skill development workshops focus on training in media outreach and presentation skills.

Annual presentations The culmination of year long activities takes place in the form of presentations, exhibition of work and cultural events. Other schools, and parents in the eco-club schools are encouraged to participate in these events.

The eco-clubs have helped develop positive environmental values among the members, giving them skills, self-confidence and a questioning mind–so important for a growing child.

GREEN SCHOOLS PROJECT, ALLIANCE TO SAVE ENERGY

A good way to ensure that energy efficiency becomes a part of everyone's thinking is to teach children about its importance. That is exactly what the Alliance's Green Schools project is accomplishing by combining three elements: facility energy management, energy usage behaviour changes, and energy-efficiency curriculum plans. The Green Schools Project designed for K-12 schools creates energy awareness, enhances experiential learning, and saves schools money on energy costs.

The project covers districts of upstate New York, Seattle, Tacoma and Philadelphia in the United States of America.

Everyone benefits from green schools!

- Students benefit from hands-on lessons in energy conservation and efficiency that will pay off now and in the future.
- Schools benefit from considerable cost savings, curriculum support, cross-functional team building, and community involvement.
- Communities benefit from the partnerships established among key stakeholders.
- The environment benefits from the more efficient use of polluting fossil fuels.

Action in Schools

Teachers trained at the start of the school session, work through the year to make students more aware of the benefits of energy saving. The principals and school facilities managers participate in helping the school save energy costs. The facilities (energy generation and supply companies), and the district authorities, actively facilitate savings by the schools. The schools get to keep part of the energy costs saved.

The project gives teachers tools for instructional and thematic planning around energy efficiency and resource conservation. Each school plans activities for teaching energy concepts, energy conservation actions and reaching out to others. For example, in one New York elementary pilot site, the team's plans included: peer learning across the grades; interaction with the custodian to learn about the building's heating equipment; application of energy concepts to one class' special Thanksgiving feast; a kindergarten energy patrol; and teaching the whole school to turn out lights and keep doors shut.

The project is interdisciplinary, involving science, math, social studies, environmental studies, technology, and language arts. The project also provides tools for curriculum intergration, so that energy efficiency does not become simply another addition to teachers' already overcrowded schedule. For example, one third grade teacher discovered that she could teach about energy transformations as she taught her customary unit on butterflies.

Opportunities for hands-on, enquiry based, and cooperative learning are inherent. For example, middle school science classes in New York surveyed their own homes to find out what energy sources they use. They shared the information with their classmates and used the data in their lessons on generating graphs.

Green Schools activities are also very congruent with service learning and project-based education. The goal, saving energy, provides a tool for authentic assessment. For example, elementary students in Seattle published a Green Schools newsletter, presented a school-wide energy conference, and audited a local church.

The Green Schools Project supports education reform through real-world applications of academic content, problem-solving, critical thinking, family and community involvement, and school to career transition. For schools, the core business of which is education, this link to education maybe the most effective means of continuing energy efficiency activities in classrooms.

Source: Alliance to Save Energy Reports

ENERGYNET

EnergyNet combines the power of telecommunications, the creativity of students and teachers, and the support of business, for an on-line project for grades 6-12, designed by Educational Dividends for TECH 2000, a coalition of education and business leaders. This programme aims to help prepare students for today's workplace. EnergyNet challenges students to operate in teams to solve problems, evaluate solutions and influence change. Since 1994, EnergyNet has provided an introduction to collaborative learning, energy conservation and telecommunications, to thousands of junior and senior high school students in over 120 schools in the USA.

EnergyNet gives students a real problem — "Is your school wasting energy?" — and the technical tools and leadership guidance to solve it. The teachers and students can draw upon a variety of tools and resources, such as the week-long summer institute training session; the project curriculum; the EnergyNet Home Page on the Internet; one-day seminars; and constant access to EnergyNet's engineers, presentation and implementation specialists; teachers and students at other schools; and EnergyNet sponsors. At school, teachers incorporate EnergyNet in a variety of classes: science, mathematics, social studies, language, arts, business, industrial technology and computer science. To complete the four phases of the project, conduct the energy audit and develop energy saving recommendations for their school board, students must assume leadership roles, split into teams, tackle different tasks and use a variety of skills. Students carry these experiences and skills into college interviews and jobs.

EnergyNet strategies in EnergyNet schools have been as diverse as the teams themselves. Some examples:

When the EnergyNet team at Cowden-Herrick High School used the project's data tables to compare their school's energy use with others, they discovered that their school spends $17,000 a year over state averages. Their energy audit found the culprit: bad windows leaking heat. Students invited an architect to

the school to help them design a solution, then told their school board what their pay back projection had shown; the new windows would pay for themselves in nine years.

Brownstown High School EnergyNet students told school board members they could save $2500 each year — or 20 per cent of their school's electric bill — by replacing 66 incandescent lights with fluorescent fixtures. Students in Rochester, Illinois discovered their high school could save $800 per classroom per year by making the same change.

The Carl Sandburg EnergyNet team helped their school save energy in part by installing motion sensors in classrooms, locker rooms and bathrooms and by putting outside lights on timers.

Technology isn't the only answer, as students at Mater Aei High School have demonstrated. At the request of the EnergyNet team, officials planted trees in strategic positions on their campus to shade and protect their school building. Students will measure the energy savings through the years ahead.

Teachers at Pioneer Junior High School began turning off lights and equipment after the EnergyNet team presented each of them with a bar graph showing energy costs in each classroom. Eighth-grade students at Viking Junior High school let teachers know they cared about energy use by issuing tickets to those teachers who left lights on when their classroom was empty. They issued "Thank You" messages to teachers who used energy efficiently.

Beyond the Classroom

The EnergyNet students involve their communities during the project, seek help from local experts and then share their own new energy conservation expertise at home, with administrators of local public buildings and with area business leaders.

Spring Wood Middle School in Hanover Park, for example, enlisted local business people to help with EnergyNet research. The owner of an electric company created an electric circuit display; an architect provided information on windows and sky lights; representatives from ComEd, the local electric company, talked about energy consumption and demonstrated experiments with electricity, and representatives from a environmental consulting firm helped with the conservation and pollution control portions of the project.

The power EnergyNet has on students is regenerated within their communities, often in surprising ways. Once they completed energy audits of their own schools, students in one community offered to check out energy usage in their local library. In another, students made this offer to local businesses. EnergyNet students will conduct free energy audits of their premises if the business owners contribute half their first year's energy savings back to the school.

"EnergyNet is an excellent example of a centrally managed and coordinated on-line instructional project. The formal activities in the project form a 'core' that provides essential structure but the project also permits and encourages participants to innovate and elaborate on the theme of energy utilization and conservation." — Michael Waugh, Interim Head, Department of Curriculum and Instruction, University of Illinois.

Source: EnergyNet Information Brochure

SUCCESS STORIES IN ENERGY EDUCATION

CONSERVE

Conserve is a New Delhi based non-profit organization, which aims to promote energy conservation and efficient use of energy in India. The organization aims to become a channel for information and thereby create awareness so that wasteful expenditure of energy become non-acceptable.

The Conserve's pilot School Education Programme, launched in 30 schools in collaboration with the World Wide Fund for Nature (WWF), India, is supported by the Ministry of Power. The programme aims to educate students, teachers, faculties and the whole school community about energy efficiency, and offers a model of effective energy efficiency in schools that can be replicated nationally and internationally. Conserve's school education programme involves 1500 students of standards 8, 9 and 11. It is operationalised through the WWF nature clubs network.

The programme has the following components:

- Forming Energy Clubs in schools
- Training selected teachers as energy education trainers
- Providing necessary tools, techniques and material to the Energy Clubs
- Ongoing feedback and support
- Involving the media to generate publicity

A reference manual has been prepared to provide information and educational material to teachers. Two teachers training programmes with more than 50 school teachers participating were conducted. Energy experts from The Ministry of Power, Tata Energy Research Institute (TERI), The Ministry of Non-conventional Energy Sources, Board members of Council of Energy Efficiency Companies, Petroleum Conservation and Research Association etc. interacted with the participants. Activity sheets were distributed to schools after the training. Those developed by TERI as part of their programme called "Fighting Pollution and Saving Oil by Inspection and Maintenance of Two-wheelers" were incorporated into Conserve's programme. Energy audit of the school building and formulation of an energy management plan were important components of the Conserve plan of action.

Each energy club was divided into Energy Research Fellows, Energy Artists, Energy Actors and Energy Architects. The Energy Architects were asked to make a model of an energy efficient building. The aim was to help them learn about the factors that influence the energy efficiency of any building such as site analysis, home orientation, configuration, envelope space planning, ventilation, heating, cooling, lighting and appliances, water pumping, heating and waste management. They could also use these models to gather and analyse data from its simulations.

A field visit to the National Thermal Power Plant Corporation Ltd. provided the students with an opportunity to see the operations of electricity generation firsthand. They also visited the ash mound point to observe conversion of fly ash into bricks and flooring material.

The programme received a momentum through a series of competitions organised by Conserve. These included debates, skits and quizes on energy and related themes.

Real wealth is knowing what to do with energy

R.Buckminster Fuller

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